

# METAL FINISHING

DEVOTED EXCLUSIVELY TO METALLIC SURFACE TREATMENTS

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## CONTENTS

Editorial	41
37th A.E.S. Convention Report	42
International Fellowship Club at Boston	44
High Production Gold Plating	46
By M. Shapiro	
The Determination of Impurities in Nickel Plating Solutions—Part II	50
By Louis Silverman	
Hard Chrome Plating on Aluminum Alloys	56
By K. Gebauer	
Electroplating Bright, Hard Nickel-Phosphorus or Cobalt-Phosphorus Alloys	65
Navy Develops a Wear Testing Machine	66
By George W. Grupp	
Shop Problems	68
Patents	70
Recent Developments	72
Engineering Data Sheet	80
Business Items	81
Manufacturers' Literature	88
News from California	91
Motor City Plating News	92
Letter to the Editor	94
Associations and Societies	95

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Contributed articles, communications, etc., on pertinent subjects are invited. Their publication, however, does not necessarily imply editorial endorsement.

## COMING SOON

In keeping with the interest on surface smoothness and levelling action in plating, a series of articles on methods for measuring and designating surface contours.

Practical electropolishing of stainless steel, with cost figures and production experience with various baths.

Spray silvering of non-conductors, with silvering formulas and spraying techniques.

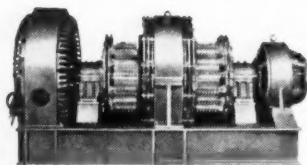
The evaluation of industrial plant wastes in the over-all waste disposal program. How a complete survey of all plant wastes ties in with plating waste disposal.

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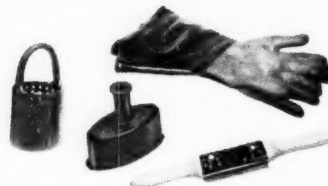
# PLAY IT SAFE

when you buy plating and polishing equipment and supplies



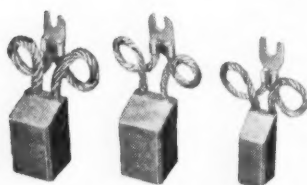
**Never gamble on low-voltage generators.** For trouble-free commutation, it *does* pay to look for fully-insulated

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# METAL FINISHING



## A CODE OF ETHICS

for the Business Magazine Editor

I believe in and seek to practice:

¶ Editorial Accuracy. With reader interest as the paramount responsibility, I shall report objectively, facts as I find them . . . seeking always to lend strongest support to the business, profession or industry I serve.

¶ Editorial Judgment. Because the publication of injudicious, unfair or untrue statements undermine honest business magazine editorial practice, I shall judge wisely the words I print.

¶ Editorial Competitiveness. While I respect the rights of other editors and honor copyright privileges, I believe in full freedom of the press and in editorial initiative.

¶ Editorial Service. My publication serves a fundamental purpose in stimulating the flow of goods and services . . . therefore, I direct my effort to building a fount of data for my readers. To them I devote the sum of my knowledge and the accumulated experience of the publication I edit.

¶ Editorial Leadership. I shall endeavor to stimulate my readers to constructive thought and action on vital issues affecting them so that my magazine may bring enlightened leadership in its field.

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George B. Hogaboom addresses opening session during ceremonies honoring Founder Members of the Society.

## Boston Proves Gracious Host For 37th Annual Convention

### Social and Technical Activities on Week's Program

**T**HE 1950 Convention of the American Electroplaters' Society once again surpassed all previous national gatherings of the Society, both in technical and social excellence. Participation by foreign experts in this Fourth International Conference on Electrodeposition was smaller than had been

anticipated, which is understandable in the light of today's monetary exchange difficulties, but the balance of the program was first class in every respect. Much credit is due Chairman *Manson Glover* and his efficient staff for the precise manner in which the large and varied program was handled.

For the benefit of those who could not attend, the following paragraphs will relate the high spots of this year's meeting. (Abstracts of the technical papers will appear in the next issue of *Metal Finishing*).

The top social event of the entire week was undoubtedly the mammoth



William J. Neill  
Supreme President



C. F. Nixon  
Supreme First Vice-President



F. J. MacStoker  
Supreme Second Vice-President



**Dr. George Swift**  
Supreme Third Vice-President



**Arthur Logozzo**  
Past Supreme President



**Dr. A. Kenneth Graham**  
Executive Secretary and Business Manager

clambake held at Nahant on Wednesday, where hungry conventioners made short work of 2,700 pounds of lobsters, several hundred broiled chickens, and literally tons of soft shell clams, all prepared and served in traditional New England style.

We never did find out who won the much talked-about ballgame between the Eastern and Western All Stars: all the spectators, and most of the players themselves were quite vague on the final score, and those who did claim to know were about evenly divided in their opinion as to who won. Anyway, all enmity was quickly forgotten in the more enjoyable struggle to surround as much food as possible at the ensuing open-air clambake.

At the opening session on Monday the membership greeted seven of the men who founded the Society in 1914. Those present from the original group were *George V. Hogaboom*, *Joseph Sterling*, *Edward Faint*, *William Schneider*, *Thomas Trumbour*, *Horace Smith*, and *Charles Cooper*. The honored guests were introduced by *Dr. George Swift*, of the Boston Branch, and each responded with a short speech. An interesting note is the fact that each of the above founders is still active in the plating field. Judging from their state of preservation, the plating field can't possibly be as tough as a lot of the younger crop of plating men claim.

#### **Electrodepositors' Technical Society Luncheon**

Thirty members of the E.T.S. were

present at Tuesday's luncheon, including *Mr. J. Vander Graaf* of Holland, *Mr. John Dale* of Australia, and the officers of the A.E.S., Congratulatory messages from *Dr. Wernick*, Secretary of the Electrodepositors' Technical Society, *Dr. Pierre Jacquet*, and other foreign dignitaries were read, and the informal atmosphere of the luncheon provided an excellent opportunity for members of the E.T.S. to become better acquainted.

#### **Election of Officers — Annual Meeting**

At the annual meeting of the Society held on Thursday, the following officers were elected to head the Society for the 1950-51 session:

President—*William Neill*, Columbus Metal Products Co., Columbus, O.

1st V.P.—*Cleve Nixon*, Ternstedt Div., General Motors, Detroit, Mich.

2nd V.P.—*Frank MacStoker*, Farand Optical Co., New York, N. Y.

3rd V.P.—*Dr. George Swift*, Consultant, Boston, Mass.

Exec. Secy. & Treas.—*Dr. A. K. Graham*, Graham & Crowley Associates, Jenkintown, Pa.

The contest for 3rd V.P. was between *Dr. Swift* and *Frank Keller*, of the Pittsburgh Branch. The balloting favored Dr. Swift by a count of 78-45, whereupon a unanimous vote was cast for Dr. Swift. Bids for the 1953 Convention site were made by the Philadelphia, Buffalo and New York branches, with the Philadelphia branch winning the voting.

#### **Awards of Merit**

The following members were honored for their contributions to the growth and welfare of the national society by being chosen to receive the Society's Award of Merit, which is granted by the Executive Board for outstanding service to the Society:

*William M. Tucker*—Eastman Kodak Co., Rochester, N. Y.

*Bernard Case*—Hanson-Van Winkle-Munning Co., Chicago, Ill.

*William N. Phillips*—General Motors Corp., Detroit, Mich.

#### **Honorary Memberships**

Delegates voted the following men as Honorary Members of the Supreme Society:

*John E. Sterling*—New York Branch

*Richard Vandereau*—Dayton Branch

*Frank J. Clarke*—Springfield Branch

#### **Branch Exhibits**

Awards for the best exhibits of plated ware were made to the following branches:

First prize (\$100)—Chicago Branch

Second prize (\$50) — Hartford Branch

Third prize (\$25)—Newark Branch

The Detroit Branch was given an Honorable Mention for their large display of plating materials. The best individual exhibit was submitted by *Mr. A. G. Bartman* and *Mr. Clem Petrosius*, of the Chicago Branch, for which they were awarded a prize of fifty dollars.



Annual Fellowship Club Open House Party promotes convention spirit on opening night.

## Fellowship Club Program Entertains Boston Conventioneers

### New Officers Elected

**T**HE Boston convention of the AES once more provided the opportunity for the Fellowship Club to entertain the conventioneers in the manner which has become traditional at these annual gatherings. The series of events sponsored by the supply firms in the metal finishing industry again added

much to the success of the convention, and the contributing firms are to be commended for their financial generosity in seeing that all who attend are assured of a good time year after year.

#### *Annual Meeting and Luncheon*

One hundred and ninety-five repre-

sentatives of the industry's supply houses and distributors got together at the Monday luncheon for the only meeting of the year of the International Fellowship Club. This was the largest attendance in the 26 years of the Fellowship Club's existence. After all those present had introduced and



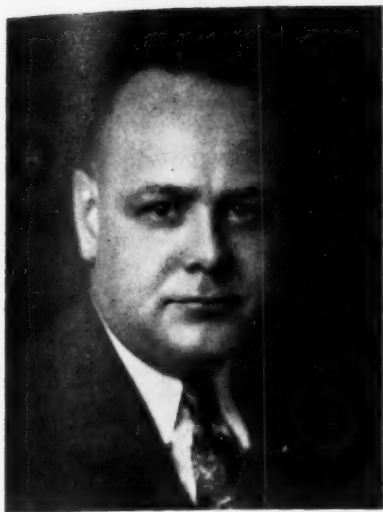
George L. Nankervis  
President



A. P. Munning  
First Vice-President



Al Braun  
Second Vice-President



Charles Berry  
Third Vice President



T. A. Trumbour  
Permanent Secretary



Rudy Hazucha  
Retiring President

identified themselves, a short business session was held, which included the election of a new slate of officers for the coming year, as follows:

President—*George Nankervis*, G. L. Nankervis Co., Detroit, Mich.

1st V.P.—*A. P. Munning*, Munning & Munning Co., Newark, N. J.

2nd V.P.—*A. Braun*, Agate Lacquer Mfg. Co., L. I. City, N. Y.

3rd V.P.—*Chas. Berry*, Maas & Waldstein, Chicago, Ill.

Permanent Secy. & Treasurer—*T. A. Trumbour*, Metal Finishing, N. Y. C.

In recognition of Tom Trumbour's 21 years of service as Secretary-Treasurer of the I.F.C., he was voted a cash gift of \$100 by the members.

The only other item of business transacted was the appointment of a committee to study and recommend certain actions to the A.E.S. regarding the method of contributing financial support to future conventions. The committee consists of *Rudy Hazucha*, *Gus Munning*, *Doug MacDermid* and *Dave Clarin*.

### Open House Party

The I.F.C. were once again hosts to all conventioners at an Open House Party held on Monday night. A superb buffet supper, dancing, and the awarding of many prizes kept those attending in high spirits, and provided the teeing-off point for the week's social activities. These Open House Parties are financed through the donation of the various supply houses in the finishing industry.

The following were the lucky winners:

R. Wallace 5 pc. Silver Tea Set—*R. A. Woofter*, Research Eng., Jones and Loughlin Steel Corp., Pittsburgh, Pa.

Oneida Silver Tableware Set—*Miss Hattie Schneider*, Standard Plating Rack Co., Chicago, Ill.

Twenty-five Dollar Government Savings Bonds—*Mrs. M. B. Diggin*, Maturan, N. J.; *Mrs. H. C. Holbert*, Syracuse, N. Y.; *Mr. J. H. McConas*, Waterbury, Conn.; *Mr. R. S. Martineau*, Syracuse, N. Y.; *Mrs. Henry Strow*, Waterbury, Conn.

### Fellowship Golf Tournament

Over 100 hopefuls entered the battle against the rugged rounds of beautiful Tedesco Country Club to compete for the many awards and the title of "Mr. Golf of the Plating Industry". Only this year "Mr. Golf" almost turned out to be a "Mrs.", for *Mrs. C. W. Gore*, wife of New England Buff Co.'s *Charlie Gore* managed to cop second place in this handicap event. There should be many a red face amongst the golfers of the "stronger sex", and a reverent bow is due *Walt Cibulskis*, of United Chromium's Detroit Research Laboratory, for saving what little remains of our masculine honor. His net score of 71 placed him in line to receive the beautiful I.F.C. trophy, a duplicate of the one won last year by *Jim Badaluco*.

Results of the day's play are as follows:

Winner — *Walt Cibulskis*, United Chromium, Detroit, Mich. I.F.C. Trophy—113-42-71a.

2nd—*Mrs. C. W. Gore*, Boston, Mass.—Golf Bag—116-45-71b.

3rd—*John Trumbour*, Metal Finishing, N. Y. C.—Traveling Bag—119-43-71c.

4th—*C. F. Heckenberg*, New England Buff Co., Boston, Mass.—Portable Sport Seat—127-56-71d.

5th—*R. Feinberg*, Beacon Supply Co., Chelsea, Mass.—Golf Glove—31-9-72.

Special awards were made to *Harold Stevens*, of the Towle Silver Co., for highest handicap (64); *J. R. Powell*, of Lewis Chemical Co., for highest gross score (139); *Rudy Skriletz*, of H. B. Salter Mfg. Co., for low gross (30); and *Mrs. S. N. McNeilly*, of Boston, for setting the pace for the runner-up.

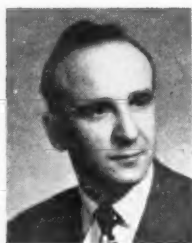
Some notable low gross scores were turned in by the following players, who are the *real* golfers of the industry but who seldom win under the Calloway Handicap System that chairman *Joe Duffy* devised for giving the "hackers" a break.

### GROSS SCORE

A. H. Clem	80
R. Skriletz	80
R. Feinberg	81
E. Lyons	82
C. G. Dinallo	83
J. R. Eisele	83
A. F. Reilly	83
H. C. Irvin	84
L. Arsenault	86
W. A. Raymond	86
C. A. Collis	88
J. Badaluco	88
R. Sanford	89

# High Production Gold Plating

By M. Shapiro, Foreman Plating Dept., Gillette Safety Razor Co., Boston, Mass.



*Mr. Shapiro is a chemical engineering graduate, cum laude, of Tufts College. Previous to his work at Gillette he was connected with Stone & Webster Eng. Corp., and the U. S. Navy Dept. at Bath Iron Works. He joined Gillette in 1943 as physical chemist. He is a member of the A.E.S. and the Electrochemical Society.*

THE electroplating of thousands of parts every hour with gold calls for certain procedures that differ considerably from the small gold plating installation. Where uniformity of color, brightness, and thickness are essential, such factors as rate of depletion of solution ingredients, maintenance of correct solution concentrations, and dragout recovery assume ever greater importance as the size of the installation and production rates increase.

If the same type of parts are being plated day after day, it is almost imperative to take advantage of full automatic plating machines to minimize the human factor as much as possible. It is also now a common practice to put on an undercoat of bright nickel, prior to the gold plate, for corrosion protection, and it is possible to incorporate a bright nickel plating tank into the automatic plating cycle ahead of the gold plating tank and perform both plating operations on one machine.

## Depassivating Nickel Plate

In changing over from plating directly over copper and brass to plating over nickel there are a few precautions to be observed. First, the surface of a bright nickel plated article has a tendency to become passive if left in the air too long. It is therefore a wise move to install an activating dip after nickel plating and just prior to gold plating. The time in the air should be minimized as much as possible, and rinsing should be thorough to make certain no nickel solution is dragged into the gold plating solution.

A good activating dip that has been used with much success is a 5 oz./gal. solution of potassium cyanide, used with direct current at about 30 to 40 amp./sq. ft. for 30 seconds. It is a good practice to filter the potassium cyanide solution before using, as it has been found that there is a small percentage of insoluble material in commercial potassium cyanide that floats on the surface of the solution and which clings tenaciously to the work as it is coming out of the activating

dip and will not rinse off. The gold will generally plate over this film, but a stain is left in the areas where the film is present, marring the uniformity of the finish. A good cycle would therefore be nickel plate, two rinses, activate, rinse, gold plate.

## Control of the Gold Bath

It is very convenient to use stainless steel anodes in the gold plating tank and to maintain the metallic gold content by the addition of gold concentrate. The gold concentrate can be prepared by the porous pot method to give a stock solution with any desired concentration.

For this process, an enamel lined steel tank should be used (see Figure 1) in which gold anodes are hung at the sides of the tank and made anodic, and the tank filled with a solution of potassium cyanide, 10 oz. per gallon. The porous pot is hung in the center of the tank and a brass or copper grid, nickel and rhodium plated for protection, is placed inside of the porous pot and made cathodic. The porous pot is filled to within 3" of the top with a saturated solution of potassium carbonate. The potassium cyanide solution should be maintained at a temperature of 140°-160°F. to prevent passivation of the gold anodes during the electrolysis. This passivation may take place when the cyanide content increases above 2%, and is due to polymerized cyanogen compounds being formed on the gold anodes producing films of brown or yellow coloration.<sup>1</sup> By keeping the temperature above 140°F., this passivation ten-

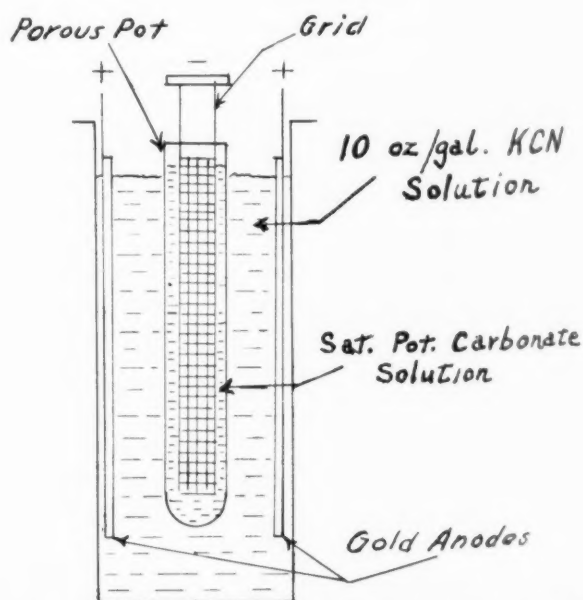


Figure 1. Porous pot method for converting metallic gold anodes to potassium gold cyanide stock solution.

density is minimized. By using a current density of about 40 amperes per square foot, it is possible to convert 3000 dwt. of gold into potassium gold cyanide in approximately six hours. This concentrate can then be diluted with water to any strength desired and used as the stock gold concentrate to be added to the gold plating tank.

The maintenance of uniform conditions during the plating process is of utmost importance, for the following reasons:

1—Where there are a variety of parts that must be assembled, all parts must match in color and brightness.

2—Parts now plated may be placed in an inventory storage for varying lengths of time and then assembled to parts that are plated weeks prior to or later than the first parts plated. Any change in the solution conditions in the intervening time will cause a variation in color conditions.

3—By plating with this uniform bright color, it is possible to do away entirely with coloring, scratch brushing and tumbling after plating.

4—At high production rates a small variation in the amount of gold plated on each part represents a very large deviation from gold cost standards.

### Color Control

The composition and operating conditions of gold plating solutions have been discussed fully in many sources<sup>2, 3, 4</sup> but for decorative gold plating over nickel it may be well to add a few additional notes. It has been found that a small percentage of nickel introduced as the cyanide to the gold plating solution is of benefit in giving a brighter, more uniform color to the gold plate itself. Actually, it is impossible to keep small amounts of nickel out of the solution, since nickel is soluble (by immersion) to some extent in the gold cyanide solution. In order to test the effect of nickel on the color plating properties of gold, the following experiment was made:

A gold solution was prepared in which there was no nickel present and various racks of nickel plated parts were plated in this solution at conditions of time, current density, and temperature ideal to the composition of the gold solution. These parts showed about 20% non-uniformity of color, especially at high current density areas. Then small amounts of nickel, in the form of the cyanide, were gradually added to the solution and more parts plated at the same definite conditions. It was found that, as the nickel concentration increased, the percentage of non-uniformly colored parts decreased until, when the nickel concentration reached the range of .02-.04 oz. per gallon, all parts were uniformly bright in both high and low current density areas.

However, instead of waiting until the desired concentration of nickel is attained by dissolution, it is well worth the effort to add the nickel to the gold solution directly as nickel cyanide and eliminate the "breaking in" period. Care must be taken not to allow the nickel concentration to build up too high, as then a white gold may be obtained. Under most ordinary circumstances dragout will aid in keeping the nickel concentration to a reasonable value.

Another point worth noting is that lower temperatures will cause less decomposition of cyanides and less

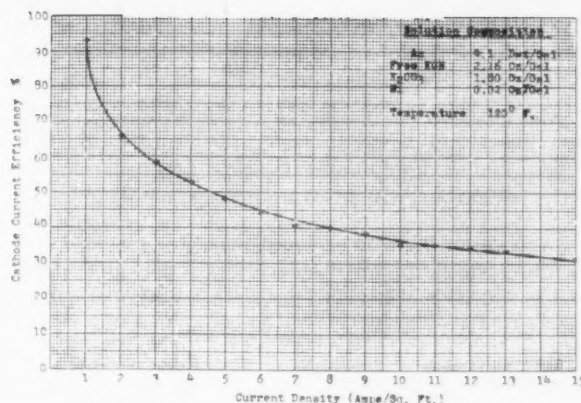


Figure 2. Cathode current efficiency as a function of the cathode current density in gold plating.

formation of carbonates and so keep the solution more uniform over longer periods of time.

### Current Density Control

In plating over nickel, a higher current density should be used than when plating over brass or copper, under the same operating conditions of solution concentration and temperature, to overcome the higher potential of nickel. Too low a current density may cause poor adherence of the gold plate or no plate at all.

It has been found that current density is the most important variable for the control of color. A small change in the current density can cause more trouble than a greater change in the other variables, such as cyanide content, carbonates, temperature, etc. Another effect of current density is in the cathode current efficiency of the plating solution. Using a solution with the following composition:

Gold	9.1 dwt./gal.
Free KCN	2.15 oz./gal.
K <sub>2</sub> CO <sub>3</sub>	1.80 oz./gal.
Nickel	0.02 oz./gal.
Temp.	120° F.

the current density was varied from 1 to 15 amperes per square foot and the following results were obtained (see Fig. 2). At 1 ampere per sq. ft., the efficiency was about 93%; at 2 amps./sq. ft., the efficiency had dropped to 66%; at 3 amps./sq. ft., to 58%; at 4 amps./sq. ft., to 53%; and at 5 amps./sq. ft., to 48%. From this point, the decrease in efficiency, as the current density increases, becomes about constant and approximates a straight line function with a slight negative slope. At fifteen amperes per sq. ft., the efficiency had dropped to 30%. These efficiencies seemed quite low and so, for a check, gold plated parts were taken from the production line and analyzed for the amount of gold. Then knowing the current and amount of time for each part, and using the efficiency that had been obtained from the experiments described above, the amount of gold on these parts was calculated. It was then found that, in those cases where the areas could be measured with accuracy, the amount of gold calculated corresponded favorably with the actual amount found on the part by analyses.

### Filtration and Impurity Control

Gold plating solutions should be able to last indefinitely if certain precautions are observed. It is good

practice to filter solutions frequently and it has been found that filtrations through a filter packed with activated carbon produces a solution that is sparkling clear. No detrimental effect on the plating solution has been observed through this practice. However, the filter papers and carbon should be saved for reclaim, since activated carbon will adsorb gold to some extent.

Even under the best of conditions, it is probable that in time metallic impurities such as copper, zinc, silver, and nickel will increase to an extent that color properties may be thrown off. These impurities may come from the insides of hollow tubes, anode and cathode bars, and from the small amounts of silver and copper that are in the original gold anodes used to make gold plating concentrate. Instead of waiting until this contamination reaches a point where it is necessary to discard the solution, it is good practice to make a periodic adjustment of the gold plating solution at a definite time interval by bleeding off a definite small percentage of the gold solution and adding fresh gold concentrate to make up for the gold removed. For example, it can easily be seen that if 1/6 of the solution is removed every month and it is assumed that impurities accumulate at a constant rate, a gold solution cannot get any older than a 6 months impurity level and so the entire solution will never have to be discarded and a new solution made. In order to ensure that fluctuations of production do not cause more impurities to be introduced in one month and less in another, the adjustment schedule could be placed on an ampere-hour basis.

#### Control by Ampere-Hour Meter

The ampere-hour meter should also be used to control the addition of gold concentrate to the gold plating solution. By frequent analysis of the gold solution and the rinses over a period of time, it is possible to obtain a factor which will allow the addition on this basis. If this factor is calculated correctly it can be made to compensate for gold plated on parts, hooks and dragout. This addition can be made by the plater at the gold tank who can keep close watch on the meter at all times and who should receive a daily supply of gold concentrate made up to the correct concentration. For example, if 30 dwt. of gold are removed from the gold solution every 100 ampere-hours, and a normal days production is 1000 ampere-hours, the plater should be supplied with at least 10 bottles of gold concentrate

each containing 30 dwt. of gold. One bottle of concentrate is then added every 100 ampere-hours. If a continuous record is kept of the additions of gold to the plating tank, and the ampere-hour meter reading each night, it is possible to estimate the gold concentration of the solution at any time without making an analysis. By comparing the estimate with the actual analysis made from time to time, a check can be kept of the ampere-hour factor. This factor will of course vary if for any reason the cathode efficiency of the gold solution changes, and so, it is important to maintain close control of the current densities which, as has been noted, have a great effect on the efficiency.

For good control the gold solution should be analyzed for gold content at least once a week; free cyanide at least once a day; carbonates once a week, and nickel and copper twice a month.

It is interesting to note that after starting with a carbonate concentration of 1.5 oz. per gallon over two years ago and by maintaining the periodic adjustment process as mentioned above, a gold solution which has been used for continuous production during this period has not had a carbonate concentration above 2.0 oz. per gallon.

#### Dragout Control

Another detail that is essential in a high production setup is some method to take care of the dragout of the gold solution. This dragout can be considerable, and some way must be provided to salvage this dragout solution. For efficient recovery, three reclaim rinse tanks after the gold plating tank are recommended, and as the parts are plated and go through these rinses, the rinses gradually build up in gold content, the first tank at a rate greater than the second, and the second tank at a greater rate than the third. The estimation of the amount of gold in each one of these dragout rinse tanks at any time without resorting to frequent analysis can be accomplished by the preparation of a graph (Fig. 3) which shows how the rise in concentration of each rinse tank can vary with the ampere-hour meter reading. Starting with fresh water in all three tanks, the concentration will vary in each tank in a manner similar to that shown in Fig. 3. This graph was prepared by actual analysis of three rinse tanks over a considerable period of time and has proven to be accurate after it was put into use.

A theoretical derivation of curves of this nature has been made by *Kushner*.<sup>5</sup>

When the first rinse tank reaches a predetermined concentration, the contents are pumped out to a large holding tank to be saved for reclaiming. The contents of the second tank are pumped into the first rinse tank and the contents of the third rinse tank are pumped into the second tank. The third rinse tank is then filled with clean water and the cycle is begun again. It can be seen that, by this method, the concentration of the third tank cannot get very high and so very little gold gets down the drain as long as this procedure is maintained accurately and faithfully.

#### Reclaiming Gold

When the large holding tank becomes full, enough cyanide is added to bring the cyanide to between 2 and

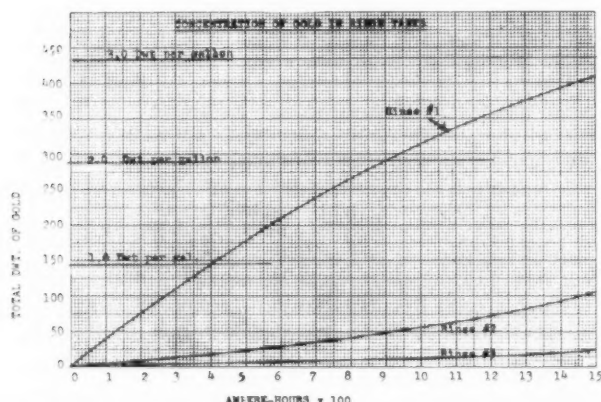


Figure 3. Chart for calculating the gold content of the reclaim rinse tanks after a given period of operation.

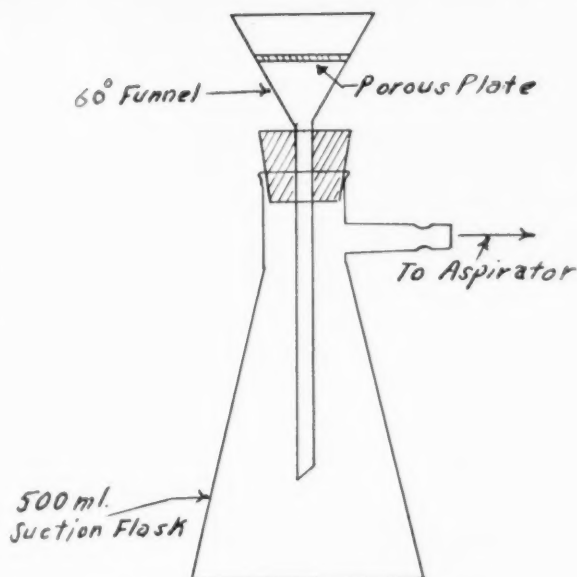


Figure 4. Set-up for suction filtration of gold.

3 ounces per gallon and stainless steel anodes and copper cathodes are arranged alternately in the tank. The gold will plate out very quickly at the start and the copper sheets must be replaced frequently at this initial period. However, as the amount of gold in the tank diminishes, the speed of plating diminishes and the copper cathodes can remain in the tank for longer periods of time. Finally, when the gold concentration reaches a point where no more gold plates out readily, the copper and stainless steel sheets are removed and powdered zinc is added to precipitate the remaining gold. The solution is stirred well and allowed to settle, and then the supernatant liquid is siphoned off and the zinc and precipitated gold are gathered with sawdust. The gold plated copper sheets and the zinc sawdust are then sent to the refinery for credit.

For the stripping of gold from plated parts, a narrow tank can be used with two copper sheets as cathodes hanging at the sides of the tank. The parts are placed in baskets on the anode rod in the center of the tank and the gold plates onto the copper sheets. When the gold plates to a thickness where it is no longer adherent to the copper sheets, the cathodes are removed and replaced. These gold plated copper plates are also sent to the refinery for credit.

#### Analysis of Gold Baths

As a final point, it is essential that an accurate method of analysis be used to maintain the correct limits of metallic gold concentration. A gravimetric analysis, although requiring a longer period of time, warrants the time expended because of its greater accuracy. A method which the author has used for sometime with very good results is as follows:

A fifty milliliter sample of the filtered plating solution is pipetted into a 400 ml. beaker and to this solution is added 20 ml. of hydrochloric acid (conc. C.P.) and 8 ml. of nitric acid (conc. C.P.) (Caution, use hood, since cyanide fumes are evolved.) The solution is then evaporated over a hot plate inside of a hood until crystals just begin to form. 30 ml. of hydrochloric acid are

then added and the solution again evaporated until crystals just begin to form again. (It is important not to evaporate too dry since the chlorauric acid crystals which form may decompose to free gold and a low result will be obtained.)

After the second evaporation, about 150 ml. of distilled water are added and the solution is brought to the boiling point and kept there for about five minutes to bring all of the crystals into solution. The solution is then filtered through a No. 41 Whatman filter paper, or equivalent, to remove any silica which may have been crystallized during the two evaporations. (An excellent method of folding filter paper for rapid filtration is given by Talbot.<sup>6</sup>) After thorough washing of the beaker and filter paper with hot distilled water, the filtrate is brought to the boiling point and 30 ml. of 6% sulphurous acid C.P. are added slowly with stirring. The gold will usually precipitate in a few seconds unless the concentration of the gold in the solution is very low, in which case, prolonged boiling will usually cause precipitation.

The solution should be allowed to digest at the boiling point until the gold settles to the bottom of the beaker and coagulates, after which it is filtered through a 7 cm. No. 42 Whatman filter paper with suction. The filter paper and gold are then ignited and weighed. If a 50 ml. sample has been used, the weight of gold obtained in grams multiplied by 48.68 is equal to the concentration of gold in dwt./gallon.

During the digestion period, the gold may go back into solution if all the nitric acid has not eliminated during the evaporation period. If this should occur, addition of more sulphurous acid will usually reprecipitate the gold.

A good setup for the suction filtration of the gold is shown in Fig. 4. For this setup, an Alfrax or Aloxite porous plate (coarse grade) 1½" diameter and ⅛" thick is cemented into a 60° funnel and the filter paper is placed on top of this plate. The funnel is inserted into a suction flask which is connected to an aspirator.

#### References

1. Louis Weisberg and A. Kenneth Graham, *Modern Electroplating*, page 205, The Electrochemical Society, Inc., N. Y., 1942.
2. Ibid., p. 200.
3. Joseph B. Kushner, *Plating and Finishing Guidebook*, pp. 97-100, Finishing Publications, Inc., New York, 1947.
4. Joseph B. Kushner, *Products Finishing*, May 1941, pp. 38-54.
5. Talbot, *Quantitative Chemical Analysis*, p. 138, B. Macmillan Co. 1935.

#### CORRECTION

In the May issue of metal Finishing the article "A New Coating Measuring Instrument" was not credited to the author, Mr. S. Lipson. We regret this oversight. Mr. Lipson also informs us that the instrument described is now covered by Patent #2,505,075.29 (May 16, 1950) and is commercially available from the Lea Mfg. Co., Waterbury, Conn.

# The Determination of Impurities in Nickel Plating Solutions—Part II

By Louis Silverman, Los Angeles, Calif.



This is a continuation of the article which appeared in the May issue of *Metal Finishing*. It contains detailed procedures for copper, iron, lead, magnesium, silica, tin, and zinc.—*Ed.*

## Copper

### QUALITATIVE SPOT TEST

Range — minimum, 0.001 oz. per gal.

Interfering elements — none

1. Pipette 1 ml. of sample into a small beaker. Add just 9 ml. of water. Mix.
2. With a stirring rod transfer a single drop of a 20% malonic acid solution to a strip of S. and S. spot test paper No. 601 suspended over a beaker.
3. With the stirring rod transfer a single drop of the solution being tested (No. 1) to the same spot on the paper.
4. With the stirring rod transfer a single drop of a 10% ethylenediamine solution to the same spot on the paper.
5. With the stirring rod transfer a single drop of a 1% dithiooxamide alcoholic solution to the same spot on the paper. If copper is present a green stain will appear. Nickel gives a violet color, and cobalt gives a brown color at the edges.

### Reference

West, P. W., Ind. Chem., Anal. Ed., 17.740 (1945).

### PRECISION COLORIMETRIC METHOD

Range — minimum, 0.001 oz. per gal.

Interfering elements — none

1. Pipette a 10 ml. sample into a 400 ml. beaker and dilute to 100 ml. with water.
2. Add 1 mg. of lead chloride.
3. Drop in a piece of Congo Red paper. Add hydrochloric acid, dropwise, until the Congo Red paper turns blue. Measure in 2 ml. of hydrochloric acid in excess.
4. Heat the solution to 60-80°C., and pass in a rapid stream of hydrogen sulfide for 10 minutes. Let stand for one hour.
5. Filter the solution through an 11 cm. No. 40 Whatman paper containing paper pulp. Wash the beaker and paper with a warm hydrogen sulfide solution containing 1 ml. of hydrochloric acid per 100 ml. of solution. Return the paper and precipitate to the original beaker. Discard the filtrate.
6. Add 15 ml. of nitric acid and 6 ml. of perchloric acid to the beaker. Evaporate to heavy fumes of perchloric acid. Cool.

7. Add 25 ml. of water and 0.1 gram of ammonium sulfate. Boil 2 minutes, then cool to room temperature.
8. Filter the slightly turbid solution through a 9 cm. No. 40 Whatman paper, containing paper pulp, into a 150 ml. beaker. Wash 3 times with cold water. Discard the paper.
9. To the filtrate add 1 gram of citric acid, and stir until the solid dissolves.
10. Insert a small piece of litmus paper, then drop in ammonium hydroxide until the paper just turns blue.
11. Add 5 mg. of solid sodium dimethylglyoxime, and stir for 2 minutes. Let the solution set for 15 minutes, and note any turbidity. Should the solution become pink, or turbid, filter the solution through a 9 cm. No. 40 Whatman paper, containing pulp, into a 125-ml. separatory funnel and wash the paper 3 times with cold water; if the solution is clear, transfer it directly to the separatory funnel.
12. Add 2 drops of thymol blue, then adjust the alkalinity (pH 9.0 to 9.3) by first making the solution slightly yellow with dilute hydrochloric acid, then adding ammonium hydroxide until the solution is just blue.
13. Pour in 20 ml. of diethyldithiocarbamate and mix. A slight brown precipitate may form.
14. Add 10 ml. of carbon tetrachloride, stopper and shake for 2 minutes. Let the liquids separate.
15. Drain the lower carbon tetrachloride layer into a dry 50 ml. volumetric flask. Extract a second time with a 10 ml. portion of carbon tetrachloride, and again drain into the volumetric. A third and a fourth extraction may be required, if the carbon tetrachloride layer is colored yellow. (If copper is unusually high and more than 4 extractions are required, add a second portion of diethyldithiocarbamate and use a 100 ml. volumetric flask.)
16. Dilute the extract to the mark with carbon tetrachloride. Mix.

### Determination of the Copper

#### PHOTOMETER

Prepare a series of 250 ml. beakers and add 0, 1, 2, 5, 10 ml. of Copper Standard Solution to the beakers. Dilute to 35 ml. with water. Begin with Step No. 9, above and proceed through No. 15. Use a 440 mμ or a 540 mμ filter with water as a "blank." Obtain "% Transmittancies" for the solutions in the 50 ml. flasks. Plot "% Transmittancy" as ordinate and "mg. Cu" as abscissa. Read "% Transmittancy" for the test solution and obtain "mg. Cu" from the graph.

#### VISUAL COMPARISON

Develop color standards in the 50 ml. volumetric flasks as outlined above. Compare the color of the test solution with those of the standards. Estimate "mg. Cu."

#### Calculation

$$\text{Cu, oz. per gal.} = 0.0134 \times \text{"mg. Cu."}$$

[Note: If it is necessary to use a 100 ml. volumetric flask (see No. 15), the result of the above calculation should be multiplied by 2.]

## Preparation of Standards and Solutions

### COPPER STOCK SOLUTION

Weigh a 0.1000 gram sample of pure copper metal and transfer it to a 250 ml. beaker. Cover the beaker and add 5 ml. of nitric acid. Warm to dissolve the metal, then add 6 ml. of perchloric acid and evaporate to heavy fumes. Cool. Add 50 ml. of water and boil for 5 minutes. Transfer the solution to a 1 liter volumetric flask, dilute to the mark with water, and mix. 1 ml. = 0.10 mg. Cu.

### COPPER STANDARD SOLUTION

By pipette, transfer 100 ml. of Copper Stock Solution to a second 1 liter volumetric flask. Add 5 ml. of perchloric acid, dilute to the mark with water and mix. 1 ml. = 0.01 mg. Cu.

### SODIUM DIETHYLDITHIOCARBAMATE

Dissolve 0.1 gram in 100 ml. of water. Preserve in a brown bottle in a dark place. Stable for 2 weeks.

### THYMOL BLUE INDICATOR

Dissolve 0.04 gram in 100 ml. of water. The color change is yellow (acid) to blue (alkaline), in the neighborhood of pH 9.

## Reference

Patridge, R. F., Ind. Eng. Chem., Anal. Ed., 17, 422 (1945).

## Iron

### PRECISION COLORIMETRIC METHOD

Range — 0.002 to 2 oz. per gal.

Interfering elements — none

1. Pipette a 50 ml. sample into a 250 ml. beaker, add 20 ml. of a cold (1:1) sulfuric acid solution, and about 0.2 gram of ammonium persulfate. Stir, dilute to 100 ml, and cool the solution to 10-15°C.
2. Add a cold 6% Cupferron Solution, dropwise, and while stirring, until the trail of the cupferron in the nickel solution is white. Add 5 ml. in excess. (Minimum amount of reagent used should be 10 ml.) Stir in a little paper pulp and let the solution stand in the ice bath for 10 minutes.
3. Filter the solution through a small filter, wash the beaker, paper and precipitate 2 times with a cold (1:10) hydrochloric acid solution. Police the beaker. Wash the paper 5 times with cold water, to remove the acid, then wash the paper 5 times with a (1:5) ammonium hydroxide solution, to remove the organic matter. Discard the filtrate.
4. Place a 100 ml. volumetric flask under the funnel, and alternately wash the paper with a hot (1:2) hydrochloric acid solution and with hot water, to dissolve the iron, catching the filtrate in the volumetric flask. Cool the volumetric flask to room temperature, dilute to the mark with water and mix well.

## Preparation of Solutions

### IRON STANDARD SOLUTION

Weigh a 0.100 gram sample of pure iron and transfer it to a 250 ml. beaker. Dissolve the sample in 20 ml. of hydrochloric acid and one drop of hydrogen peroxide. Add 50 ml. of water and boil carefully for 5 minutes. Transfer the solution to a 1 liter volumetric flask, dilute to the mark with water and mix well.

### o-PHENANTHROLINE

Dissolve 0.5 gram of the solid in 100 ml. of hot water. The solution is stable.

### CUPFERRON REAGENT

Stir 6 grams of the solid with 100 ml. of cold water. Store in the ice box. Keeps for 30 days.

### HYDROXYLAMINE HYDROCHLORIDE

Use the solid.

### SODIUM ACETATE

Use  $\text{NaC}_2\text{H}_3\text{O}_2 \cdot 3\text{H}_2\text{O}$ .

## Preparation of Color Standards

a—Prepare a series of 50 ml. volumetric flasks. Add 0 ml. (0.00 mg. Fe), 0.5 ml. (0.05 mg. Fe), 1.0 ml. (0.10 mg. Fe) etc., of Iron Standard Solution to each beaker. Add 20 ml. of water to each beaker. Add 0.1 gram of hydroxylamine hydrochloride to each beaker. Drop in a piece of Congo Red paper. The paper should turn blue, but if the paper is red drop in concentrated hydrochloric acid until the paper does turn blue. Add 0.1 gram portions of sodium acetate until the paper turns red. Very carefully add (1:1) hydrochloric acid until the paper again turns blue. Add 2 ml. of o-phenanthroline reagent. Shake. Dilute to the mark with water, and mix. Let stand 5 minutes.

### PHOTOMETER

b—The filter may be 525 m $\mu$  or 425 m $\mu$  (high iron). Obtain "% Transmittancies" for the Iron Standard Solutions. Plot "% Transmittancy" as ordinate and "mg. Fe" as abscissa on semi-log paper.

### VISUAL COMPARISON

c—Preserve the color standards in stoppered test tubes. Discard after 30 days.

## Determination of the Iron

### PRELIMINARY ESTIMATION

From the 100 ml. volumetric flask pour about 5 ml. of sample into a test tube. Proceed, as in a and c above and from the intensity of the red color choose a suitable volume, "A ml." for the final test.

By pipette, transfer the chosen volume, "A ml." to a 50 ml. volumetric flask. (If volume A is to be greater than 25 ml., transfer the test solution to a 250 ml. beaker, evaporate the test solution to a small volume, then re-transfer to the 50 ml. volumetric flask.) Proceed, as in "a" to develop the red color and dilute to volume. Let stand 5 minutes.

Obtain "% Transmittancy" for the test solution, and read "mg. Fe" on the curve, or if using visual comparison, by comparison with the visual standards obtain "mg. Fe."

## Calculation

$$\text{Fe, oz. per gal.} = 2.67 \times \frac{\text{"mg. Fe"}}{\text{"A ml."}}$$

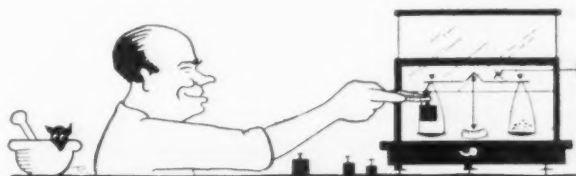
## Lead

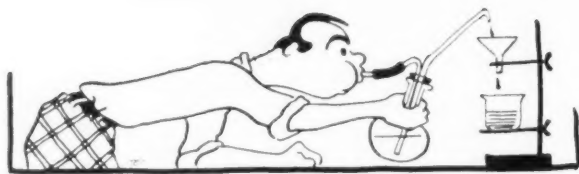
### PRECISION COLORIMETRIC METHOD

Range — 0.0003 to 0.05 oz./gal.

Interfering elements — cadmium (50 times lead content), bismuth (5 times lead content); 0.5 oz. per gal. of zinc.

1. Pipette a 50 ml. sample into a 400 ml. beaker. Run a "blank" at the same time.
2. Add 10 ml. of a 50% citric acid solution, 100 ml. of water, 10 drops of methyl orange (1 gram per liter of water), and 0.1 gram of copper sulfate. If the solution is red, or orange, add ammonium hydroxide until the red color fades to a yellow or blue color.
3. To the yellow or blue solution add hydrochloric acid until the solution turns Congo Red paper blue, and the solution is somewhat red.
4. Add 10 grams of ammonium sulfate, 25 ml. of formic acid, heat the solution to 60-80°C., and pass in a rapid stream of hydrogen sulfide for 10 minutes. Stir in a little paper pulp, and let stand for 10 minutes.
5. Filter the solution through an 11 cm. No. 40 Whatman





paper. Wash the beaker, paper and precipitate with a hot 1% formic acid solution saturated with hydrogen sulfide. Discard the filtrate.

6. Return the paper and precipitate to the 400 ml. beaker. Add 25 ml. of nitric acid and 8 ml. of perchloric acid. Mix. Evaporate the solution to heavy fumes of perchloric acid. Cool. Add 50 ml. of water and 5 ml. of hydrochloric acid. Boil for 5 minutes and cool.
7. Add 5 ml. of 50% tartaric acid solution.
8. Add ammonium hydroxide until the solution becomes blue or light green, but not deep blue. If the solution becomes deep blue, decolorize it by adding several drops of tartaric acid solution. A precipitate may appear. Cool the beaker in running water.
9. Carefully add potassium hydroxide solution, 2 to 3 ml., until the solution turns to a deep, blue color (complex copper tartrate). Cool again.
10. Slowly, and with stirring, add sodium cyanide solution, 20 to 30 ml., until the blue color changes to a light yellow or water-white solution.
11. Add 4 drops of thymolphthalein indicator and adjust the pH as follows:
  - (i) if the solution is deep blue, add tartaric acid solution until the solution is pale blue, then make the solution deep blue with ammonium hydroxide.
  - (ii) if the solution is only pale blue make it a deeper blue with ammonium hydroxide.
12. Transfer the solution to a 250 ml. separatory funnel.

### Preparation of Solutions

#### LEAD STOCK SOLUTION

Weigh 0.320 gram of lead nitrate (or 0.268 gram of lead chloride) and transfer to a 1 liter volumetric flask. Dilute to the mark with a 1% nitric acid solution, and mix well. 1 ml. = 0.2 mg. of lead.

#### LEAD STANDARD SOLUTION

By pipette, transfer 100 ml. of lead stock solution to a 1 liter volumetric flask, and dilute to the mark with a 1% nitric acid solution. Mix well. 1 ml. = 0.02 mg. of lead.

#### DITHIZONE SOLUTION

Dissolve 0.010 gram of dithizone in 500 ml. c.p. carbon tetrachloride. Keep in a cool dark place. When a red tint appears in the bottom of the glass container, discard the reagent. The reagent will keep for 5 days in a refrigerator.

#### TARTARIC ACID SOLUTION

Dissolve 500 grams in warm water and dilute to 1 liter with water.

#### POTASSIUM HYDROXIDE SOLUTION

Dissolve 50 grams in water and dilute to 100 ml. with water.

#### SODIUM CYANIDE SOLUTION

Dissolve 10 grams in water and dilute to 100 ml. with water.

#### THYMOLPHTHALEIN INDICATOR

Dissolve 0.04 gram in 100 ml. of alcohol. The indicator is blue above pH 9.

#### AMMONIA-CYANIDE REAGENT

Dissolve 10 grams of sodium cyanide in 200 ml. of water and 75 ml. of ammonium hydroxide, mix, and dilute to 500 ml. with water. Discard after 30 days.

### Determination of the Lead

13. To the solution in the separatory funnel (No. 12) add 25 ml. of green dithizone reagent, shake 30 seconds, then let settle for 2 minutes. Note the color of the lower (carbon tetrachloride) layer:
  - (a) Green. Lead is absent, or amount present is not greater than 0.0003 oz. per gal. The test is completed.
  - (b) A green-red shade. Drain the lower layer into separatory funnel 2. Extract the water layer in funnel 1 with colorless carbon tetrachloride and drain the lower layer into funnel 2. Discard the water layer. Proceed to No. 14.
  - (c) Pink (about 0.0007 oz. per gal.). Drain the lower layer into funnel 2. Again extract the water layer, as in No. 13. Drain the lower layer into funnel 2. Re-extract as in No. 13, and repeat until the green dithizone reagent does not turn red. Three extractions may be required. Proceed to No. 14.
  - (d) Red (0.001 or more oz. per gal.). Continue as in (c. Pink). From 3 to 6 extractions may be required, depending on the amount of lead present. Proceed to No. 14.
14. Prepare wash reagent as follows: Place 25 ml. of 1% nitric acid in a beaker, add 2 drops of thymolphthalein indicator, and add ammonia-cyanide reagent, (about 5 ml.) until the solution is deep blue (pH 10). This wash reagent is prepared when needed.
15. Pour the wash reagent into funnel 2, containing the carbon tetrachloride extract. Shake 30 seconds, and let stand for 2 minutes.
16. Dry the outlet tip of the funnel with rolled filter paper. Place funnel 2 over a clean, dry funnel #3, and carefully drain all but 1 ml. of the red (lower) layer into the dry funnel #3.
17. Filter the red solution from funnel #3 through a small dry filter paper into a dry 150-ml. beaker (for 13d use a larger beaker).
18. Extract the aqueous solution in funnel 2 with 10 ml. of colorless carbon tetrachloride. Let stand. Drain nearly all of the carbon tetrachloride layer from funnel 2 into funnel 3, carefully sealing off the water. Shake funnel 3, wetting all red stains inside the funnel. Use the carbon tetrachloride from funnel 3 to "wash" the filter paper.
19. Transfer the red carbon tetrachloride solution from the beaker to an appropriate-size volumetric flask. Usually a 100 ml. volumetric flask is the correct size. Record the volume of volumetric flask as, "V, ml." Wash out any colored residue from the beaker with some carbon tetrachloride. Dilute the red solution to the mark with colorless carbon tetrachloride, and mix well.

#### PHOTOMETER

Use a 525 mμ filter, use water as the "100% Transmission" blank and obtain "% Transmittancy" of the test solution. Prepare the curve as below. Read "mg Pb."

#### VISUAL COMPARISON

Compare the unknown test solution with standards, as prepared below. Read "mg. Pb."

### Preparation of Standards

Prepare a series of 250 ml. beakers. Add to each 0.0 ml. (0.00 mg. Pb), 1.0 ml. (0.02 mg. Pb), 20 ml. (0.04 mg. Pb), etc. Proceed according to No. 6 (adding the 50 ml. of water, etc.) using 100 ml. volumetric flasks to contain the extracts. Plot the curve using "% Transmittancy" as ordinate and "mg. Pb" as abscissa.

Permanent "water standards" may be made from cobalt nitrate solutions. See Reference #1.

#### Calculation

$$\text{Pb, oz. per gal.} = 0.000027 \times \text{"mg. Pb"} \times \text{"V, ml."}$$

#### Reference

1. Silverman, L., Ind. Eng. Chem., 20,906 (1948).
2. Silverman, L., Ind. Eng. Chem., Anal. Ed., 19,698 (1947).

## Magnesium

### PRECISION COLORIMETRIC METHOD

Range — 0.001 or more, oz. per gal.

Interfering elements — none

1. Pipette a 25 ml. sample into a 400 ml. beaker.
2. Add 25 ml. of nitric acid and 20 ml. of perchloric acid. Cover the beaker and evaporate the solution to heavy fumes of perchloric acid. Cool. Add 100 ml. of water and warm to solution. (If phosphates are known to be present, add several drops of a 10% zirconyl chloride solution to precipitate zirconyl phosphate. It is not necessary to filter at this point.)
3. Add 10 drops of methyl orange indicator (1 gram per liter). Slowly add a 10% sodium hydroxide solution until a precipitate forms, or until the red color of the solution turns yellow or blue.
4. Add 2 ml. of hydrochloric acid and heat the solution to 60-80°C. Pass in a rapid stream of hydrogen sulfide gas for several minutes.
5. Drop in ammonium hydroxide until a black precipitate appears, then slowly continue the addition of ammonium hydroxide until the solution turns red litmus paper to blue. Stir in a little paper pulp and allow the precipitate to settle. The supernatant liquid should be yellow.
6. Cool the beaker in running water to separate excess perchlorates. Filter the solution through a 15 cm. No. 40 Whatman paper and wash the beaker, precipitate and paper with cold water that has been saturated with hydrogen sulfide and made alkaline with ammonium hydroxide. Discard the paper and contents.
7. To the filtrate add liquid bromine in excess, acidify with sulfuric acid, evaporate the solution to 25 ml., then cool.
8. Filter the solution through a 9 cm. No. 42 paper, containing paper pulp, into a 50 ml. volumetric flask. Wash the beaker, paper and precipitate with cold water. Discard the paper. Dilute the solution to the mark with water, and mix well.

#### Preparation of Solutions

##### TITAN YELLOW

Dissolve 0.5 gram of reagent in 1 liter of water.

##### CALCIUM SULFATE SOLUTION

Mix 5 gram of calcium sulfate with one liter of water. Let stand over night. Decant the clear filtrate.

##### STARCH SOLUTION

Make a paste of 10 grams of soluble starch and 100 ml. of water. Pour the paste into 900 ml. of hot water. Stir and keep warm until a clear solution is obtained. Add 1 gram of benzoic acid as preservative. Discard the solution when one drop does not turn a dilute iodine solution to an intense blue color.

##### SULFURIC ACID SOLUTION

3 ml. in 100 ml. of water.

##### SODIUM HYDROXIDE SOLUTION

Dissolve 8 grams of sodium hydroxide in water. Preserve in a rubber-stoppered bottle. (Rub white dust off rubber.) Discard after one week.

##### MAGNESIUM STANDARD SOLUTION

Weight 0.1 gram of bright magnesium metal and transfer it to a 250 ml. beaker. Cover with 100 ml. of water, and add 10 ml. of hydrochloric acid, in small portions, until the metal has dissolved. Transfer the solution to a 100 ml. volumetric flask, dilute to the mark with water, and mix well. 1 ml. = 0.1 mg. Mg.

#### Preparation of Standards and Curves

##### PHOTOMETER

Prepare a series of glass-stoppered 100 ml. volumetric flasks. Add in order, 0.0 ml. (0.00 mg. Mg), 1.0 ml. (0.10 mg. Mg) 2.0 ml. (0.20 mg. Mg), etc.

9. Add in order to each flask 1 ml. of Sulfuric Acid Solution, 10 ml. of Starch Solution and 20 ml. of Calcium Sulfate Solution. Mix. Add 10 ml. of Titan yellow solution and 10 ml. of Sodium Hydroxide Solution. Mix. Dilute to the mark with water. Stopper the flasks and shake vigorously to develop maximum red color. Let stand for 5 minutes. Use water as the blank and obtain readings with a 525 mμ filter. Plot "% Transmittancies" as ordinate and "mg. Mg" as abscissa. Set up a new curve for every new batch of reagents.

##### VISUAL COMPARISON

Proceed to develop standards as above, and note the color intensities of the standards.

#### Determination of the Magnesium

##### PRELIMINARY TEST

By pipette, withdraw 5 ml. of test sample (No. 8) from the 50 ml. volumetric flask and transfer it to a 100 ml. volumetric flask. Proceed as in No. 9, to develop the red color. Estimate the correct volume ("A ml.") to be used for the final test.

##### PHOTOMETER

By pipette withdraw the correct volume, "A ml.", from the 50 ml. volumetric flask and transfer it to a glass-stoppered volumetric flask. Proceed as in No. 9 to develop the red color. Obtain "% Transmittancy" and read "mg. Mg" from the curve.

##### VISUAL COMPARISON

Proceed as above to develop the red color. Compare the test solution color with standards. Estimate "mg. Mg."

#### Calculation

$$\text{Mg, oz. per gal.} = \frac{0.267 \times \text{"mg. Mg"}}{\text{"A. ml."}}$$

#### Reference

Ludwig, E. E., and Johnson, C. R., Ind. Eng. Chem., Anal. Ed., 14.895 (1942).

## Silica

### RAPID GRAVIMETRIC METHOD

Range — 0.001 oz. per gal., or more.

Interfering elements — tungsten, molybdenum, phosphorus, fluorine

1. Pipette a 25 ml. sample into a 400 ml. beaker, add 25 ml. of nitric acid and 35 ml. of perchloric acid, cover the beaker and evaporate to heavy fumes of perchloric acid. Cool. Add 50 ml. of hot water, and stir.
2. Add 50 ml. of hydrochloric acid, and stir to complete solution of the green salts.
3. Filter through an 11 cm. No. 40 Whatman paper, containing paper pulp. Wash the beaker and paper, 6 times alternately with hot water and with hot (1:2) hydrochloric acid solution. Finally, wash 6 times with hot water.
4. Transfer the paper and contents to a dry (porcelain, silica or platinum) crucible. Dry the paper on the hot plate, then set the crucible on an asbestos-center wire gauze, above a Fisher burner and heat to char the paper. Ignite the crucible over the open burner or in an electric furnace.
5. Cool the crucible, brush out the residue onto the balance pan and weigh as SiO<sub>2</sub> gram. (If a platinum crucible is available, weigh crucible plus contents, add 1 drop of water, 1 drop of sulfuric acid and 5 drops of hydrofluoric acid. Evaporate, fume off sulfuric acid, ignite, cool and weigh. Loss in weight is SiO<sub>2</sub>.)

#### Calculation

$$\text{SiO}_2, \text{ oz. per gal.} = \text{SiO}_2, \text{ gram} \times 5.3$$

#### Reference

Silverman, L., Ind. Eng. Chem., Anal. Ed., 14.554 (1942).

## PRECISION COLORIMETRIC METHOD

Range — 0.0008 to 0.003 oz. per gal.

Interfering elements — tungsten, antimony

1. Pipette a 25 ml. sample into a 400 ml. beaker, dilute to 100 ml. with water, and add ammonium hydroxide until the solution is blue to litmus paper. Now add hydrochloric acid until the solution is just blue to Congo Red paper, and 2 ml. of hydrochloric acid in excess.
2. Add 5 mg. of copper sulfate, dilute the solution to 250 ml. and heat to 60-80°C.
3. Pass in a rapid stream of hydrogen sulfide for 10 minutes. Stir in a little paper pulp and allow the precipitate to settle.
4. Decant the clear liquid through an 11 cm. No. 40 Whatman paper, then transfer the precipitate to the paper with a formic acid-hydrogen sulfide wash solution (see below). Wash the beaker and paper 3 times. Discard the filtrate.
5. Place the original 400 ml. beaker under funnel. Wash the paper and precipitate once with cold water. Wash the paper and precipitate 6 times with warm sodium sulfide solution. Discard the paper and residue.
6. To the filtrate, add hydrochloric acid until the solution is acid to litmus paper, then add 10 ml. in excess.
7. Boil gently to coagulate the sulfur, stir in a little paper pulp and filter the solution through an 11 cm. No. 40 Whatman paper into a 150 ml. beaker. Wash the beaker, paper and precipitate 6 times with hot (1:1) hydrochloric acid solution. Discard the paper.
8. Add 1 pellet of zinc shot to the beaker, and gently evaporate the solution to 15-20 ml. Cool and transfer the liquid to a 25 ml. volumetric flask. Rinse the beaker with (1:1) hydrochloric acid solution, draining into the volumetric flask. Dilute to the mark with the (1:1) hydrochloric acid solution. Mix well.

### Preparation of Solutions

#### TIN STANDARD SOLUTION

Weigh 0.100 gram of pure tin metal. Transfer to a 100 ml. beaker. Add 10 ml. of sulfuric acid, cover and heat until the metal dissolves, the sulfur volatilizes and heavy fumes of sulfur trioxide are evolved. Cool. Add 50 ml. of water. Mix and cool. Transfer the solution to a 2 liter volumetric flask with a (1:2) hydrochloric acid solution. Dilute to the mark with the (1:1) hydrochloric acid solution. Mix well. 1 ml. = 0.05 mg. tin.

#### SODIUM SILICATE SOLUTION

Weigh 1.00 gram of silica and 5 grams of sodium carbonate. Transfer to a platinum crucible, cover and heat to complete fusion of the solids. Cool. Transfer the crucible and cover to a 400 ml. beaker. Warm with 200 ml. of water until solution is complete. Transfer the solution to a 1 liter volumetric flask and dilute to the mark with water. Mix.

#### MOLYBDATE SOLUTION

Weigh 5.3 grams of ammonium molybdate and transfer to a 400 ml. beaker. Add 100 ml. of water and stir to solution. Slowly pour the cold sulfuric acid solution into the molybdate solution, stirring continually. Transfer the liquid to a graduate and dilute to 200 ml. with water. Mix well.

#### SILICOMOLYBDATE REAGENT

Transfer 10 ml. of molybdate solution to a 1 liter volumetric flask. Fill the flask about two-thirds with water. Mix. Pipette in 2.5 ml. of sodium silicate solution, dilute to the mark with water and mix. Allow to stand for at least 30 minutes so that the chemicals may combine. Prepare fresh, daily.

#### ZINC SHOT

The zinc must be low in tin, iron, arsenic and lead; cadmium does not interfere.

#### FORMIC ACID-HYDROGEN SULFIDE WASH SOLUTION

Add 10 ml. of formic acid to 1 liter of water. Saturate with hydrogen sulfide gas.

## SODIUM SULFIDE SOLUTION

Add about 10 grams of sodium sulfide to 1 liter of water; as an alternative, add 10 grams of sodium hydroxide to 1 liter of water, and saturate with hydrogen sulfide gas.

### Preparation of Standards

#### PHOTOMETER

9. Prepare a series of 25 ml. volumetric flasks, and add in order, to each, 0.0 ml. (0.000 mg. Sn), 0.5 ml. (0.025 mg. Sn), 1.0 ml. (0.05 mg. Sn), 2.0 ml. (0.10 mg. Sn), etc. Add 10 ml. of hydrochloric acid to each flask and dilute to the mark with water. Mix. Pour the standard solutions into 250 ml. Erlenmeyer flasks, rinse each volumetric flask with 5 ml. of (1:1) hydrochloric acid and drain into the Erlenmeyer flasks. Heat the solutions just to boiling and add 4 to 5 gram of zinc shot. Boil for 1 minute, shaking occasionally. Pour 100 ml. of the silicomolybdate reagent into the Erlenmeyer flask, mix and decant immediately into a 150 ml. volumetric flask. The mixing of reagents and the decanting of the blue liquid from the zinc must be accomplished within 10 seconds. Dilute the blue solution to the mark with water, and mix. Let stand for 5 minutes. Use water as the 100% blank, and obtain photometric readings for the standard solutions. Plot "% Transmittancies" as ordinates and "Mg. Sn" as abscissa. Discard after 30 minutes.

#### VISUAL COMPARISON

Proceed as above, and note the color intensities of the standards.

### Determination of the Tin

#### PHOTOMETER

10. Pour the test solution (No. 8) into a 250 ml. Erlenmeyer flask, rinse the volumetric flask with 5 ml. of hydrochloric acid and drain into the Erlenmeyer flask. Continue, as in No. 9, and obtain "% Transmittancy." Read "mg. Sn" on the curve.

#### VISUAL COMPARISON

Proceed, as in No. 10, but compare the color with standard solutions.

Estimate "mg. Sn."

### Calculation

$$\text{Sn, oz. per gal.} = 0.0054 \times \text{"mg. Sn"}$$

### Reference

Baker, I., Miller, M., and Gibbs, R. E., Ind. Eng. Chem., Anal. Ed., 16,269 (1944).

## Zinc

## PRECISION COLORIMETRIC METHOD

Range — 0.005 oz. per gal., or more.

Interfering elements — none

1. Pipette a 25 ml. sample into a 400 ml. beaker, and proceed as outlined under the Determination of Tin (Precision Colorimetric Method) steps 1 thru 4.
2. Return the paper and contents to the original beaker, add 25 ml. of nitric acid and 8 ml. of perchloric acid, and evaporate to heavy fumes of perchloric acid. Cool.
3. Add 75 ml. of water, 5 ml. of hydrochloric acid, and boil out the free chlorine. Cool.
4. Filter the solution through a small funnel into a 250 ml. volumetric flask. Dilute to the mark with water, and mix well.

### Preparation of Solutions

#### ZINC STOCK SOLUTION

Weigh 0.100 gram of pure zinc metal and transfer it to a 250 ml. flask. Dissolve the zinc in 90 ml. of water, 10 ml. of hydrochloric acid and one drop of hydrogen peroxide. Transfer the solution to a 1 liter volumetric flask, dilute to the mark with water and mix well. 1 ml. = 0.010 mg. Zn.

#### DITHIZONE-CARBON TETRACHLORIDE SOLUTION

Dissolve 0.10 gram of dithizone in 1 liter of carbon tetrachloride. Store in refrigerator. The reagent keeps for one week. Discard when a red color appears in the bottom of the container.

#### DITHIZONE-CHLOROFORM SOLUTION

Dissolve 0.10 gram of dithizone in 1 liter of chloroform. Store in the refrigerator. Keeps for 1 week. Discard when a red color appears in the bottom of the container.

#### SODIUM ACETATE SOLUTION

Dissolve 6.7 grams of  $\text{NaC}_2\text{H}_3\text{O}_2 \cdot 3\text{H}_2\text{O}$  in 1 liter of water. Test for impurities by shaking with dithizone solution. Purify, if necessary.

#### SODIUM THIOSULFATE SOLUTION

Dissolve 50 grams of  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$  in 100 ml. of water. Test for zinc.

#### THIOSULFATE-ACETATE WASH SOLUTION

To a 500 ml. cylindrical graduate add 225 ml. of sodium acetate solution, 10 ml. of thiosulfate solution, 200 ml. of water and 4 ml. of nitric acid (measured out in a small graduate). Dilute to 500 ml. with water. Transfer to a bottle and mix. Used for washing the carbon tetrachloride extract when necessary.

#### SODIUM SULFIDE WASH SOLUTION

0.5 gram of sodium sulfide in 1 liter of water.

#### APPROXIMATE 0.1 N HYDROCHLORIC ACID SOLUTION

Carefully measure 9.5 ml. of hydrochloric acid into a 1 liter volumetric flask. Dilute to the mark with water. Mix well.

### Preparation of Standards

#### AMMONIUM HYDROXIDE

This reagent may contain zinc. Run a blank test.

#### PHOTOMETER

Prepare a series of 125 ml. separatory funnels, and add in order, to each, 0.0 ml. (0.000 mg. Zn), 0.5 ml. (0.005 mg. Zn), 1.0 ml. (0.010 mg. Zn), 2.0 ml. (0.020 mg. Zn), etc. Dilute each solution to about 35 ml. with water. Drop in pieces of Congo Red paper and litmus paper. Adjust the acidity to pH 5.0 to 5.5 with Sodium Acetate Solution and 0.1 N Hydrochloric Acid Solution. The Congo Red paper and the litmus paper should each be red. Bromocresol green (blue, above pH 5), if available, may be used. Add 0.5 ml. of Thiosulfate solution to each funnel. Mix. Add 15 ml. of Dithizone-Carbon Tetrachloride Solution to each funnel. Stopper the funnels and shake for 1 minute. Allow to separate for 2 minutes. Drain the lower (carbon tetrachloride) layer into a second funnel (funnel #2). Continue extractions with 10 or 15 ml. portions until the extract for each standard is green (original dithizone color). To the respective #2 funnels add 5 ml. of water, stopper, mix, and allow the layers to separate. Meanwhile, rinse and wash the #1 funnels. Drain the lower (carbon tetrachloride) layers from the #2 funnels into the #1 funnels. Add 10 ml. of Sodium Sulfide Solution to each of the funnels, mix and allow the layers to separate. Meanwhile, rinse and wash the #2 funnels. Drain the lower (carbon tetrachloride) layer into the #2 funnel. Repeat the sulfide solution washes until the wash solution remains colorless. When the wash solution is colorless, dry the outlet tip of the funnel with rolled filter paper. Drain all but 1 ml. of the red solution into a 50 ml. volumetric flask, then close the stopcock. Add 5 ml. of colorless carbon tetrachloride to the funnel, mix, separate and carefully drain out the carbon tetrachloride into the volumetric flask. Discard the sulfide solution. Fill the volumetric flask to the mark with colorless carbon tetrachloride. Mix. Use carbon tetrachloride as the "100% Transmittancy" blank, and obtain readings with a 525 mμ filter (540 mμ preferred). Plot "% Transmittancy" as ordinates and "mg. Zn" as abscissa on semilog paper.

#### VISUAL COMPARISON

Proceed as above and note the intensity of colors. 100 ml. volumetric flasks may be used in place of the 50 ml. flasks.

### Determination of the Zinc

#### PRELIMINARY ESTIMATION

Transfer about 10 ml. from the test sample volumetric flask (No. 4) to a 125 ml. separatory funnel. Add 25 ml. of water. Drop in pieces of Congo Red paper and litmus paper and adjust to pH 5 with Sodium Acetate Solution. Add 0.5 ml. of Sodium Thiosulfate Solution, and mix. Add 15 ml. of Dithizone-Chloroform Solution, mix, and allow the layers to separate. Estimate the volume of test sample that will be required to give a reading midway on the graph, or most suitable for visual comparison.

#### FINAL ESTIMATION

By pipette, transfer the correct volume, "V. ml.", from the 250 ml. volumetric flask to the 125 ml. separatory funnel. If necessary, dilute the volume to 35 ml. with water. Drop in pieces of Congo Red paper and litmus paper, and cautiously add Sodium Acetate Solution until the blue Congo Red paper turns to red; the litmus paper should remain red, without a tinge of purple. Add 0.5 ml. of Sodium Thiosulfate, and mix. Add 15 ml. of Dithizone-Chloroform Solution, mix for 30 seconds, then allow the two layers to separate for two minutes. Drain the lower (chloroform) layer into funnel #2. Again extract the water solution in funnel #1 with 15 ml. of Dithizone-Chloroform Solution and allow the layers to separate. If the lower layer is green, or brownish-green, the extraction is completed, but if the lower layer is red, repeat extractions with fresh portions of Dithizone-Chloroform Solution until the extract is green or brownish green. Drain each extract into funnel #2. (Discard the aqueous solution in funnel #1 and wash the funnel). Add 10 ml. of water to funnel #2, stopper and shake the funnel. Let settle for two minutes then drain the lower (chloroform) layer into the clean funnel #1. (Discard the wash water in funnel #2 and wash the funnel.) Extract the chloroform solution in funnel #1 with 5 ml. of 0.1 N Hydrochloric Acid, let the layers separate and drain the lower (chloroform) layer into funnel #2. Again extract the chloroform solution with 5 ml. of 0.1 N Hydrochloric Acid solution, let the layers separate. This time, drain the lower (chloroform) layer into a beaker, and discard. Combine the two 5 ml. hydrochloric acid extracts. Add 15 ml. of water. As before drop in pieces of Congo Red paper and litmus paper and adjust to pH 5-5.5 with Sodium Acetate Solution. Add also 0.5 ml. of Thiosulfate Solution. This time, extract with 15 ml. of Dithizone-Carbon Tetrachloride Solution and complete as detailed under Preparation of Standards, above. Record the "Mg. Zinc."

#### Calculation

$$\text{Zn, oz. per gal.} = 1.34 \times \frac{\text{"mg. Zn"}}{\text{"V. ml."}}$$

#### References

1. Fischer, H., and Leopoldi, G., Z. anal. Chem., 102,241 (1937).
2. Bricker, L. G., Weinberg, S., and Proctor, K. L., Ind. Eng. Chem., Anal. Ed., 17,661 (1945).

### CORRECTION

In the April issue, page 66, under the Calculation for Cobalt, the following note should be added:

Should manganese be present in the nickel bath, a correction for its presence must be made when using this scheme of analysis. This is done by multiplying the figure for Manganese by the factor 1.07, and subtracting this from the Cobalt figure obtained above.

# Hard Chrome Plating on Aluminum Alloys

By K. Gebauer

THE favorable results obtained in the surfacing of iron and steel with hard chromium coatings suggested that the hardness and wear resistance of aluminum and its alloys could be considerably improved in the same way, and that new uses for this metal would then be found. Although more or less hard oxide layers can be produced on aluminum by anodizing, there exists a demand for a specially hard metallic layer, as anodic coatings are not always completely satisfactory as regards hardness and wear resistance.

The production of hard chromium layers on aluminum requires suitable pre-treatment, so that the thickness of the deposit need be only 0.1 mm at most. The chromium layer should be easily and accurately machinable and so should be as smooth as possible. It should not peel off during machining or under mechanical or thermal stress, since hard chromium-plated aluminum articles are frequently heated to 200-300°C. under stress.

## Requirements

It should not be forgotten that requirements for the thickness and subsequent machining vary. Coatings for decorative purposes are at most only a few hundredths of a millimetre thick and must be smooth and even enough to enable a sufficiently high polish to be obtained without machining. Care should be taken to see that the surface of the aluminum is roughened as little as possible during pre-treatment. Adhesion requirements for decorative coatings, apart from those on articles to be thermally stressed, are not severe and are considerably less than for hard chromium coatings. The latter generally need to be machined, since it is hardly possible to deposit the coating so uniformly as to maintain the required dimensional accuracy.

The first attempts to produce hard chromium coatings on aluminum naturally originated from the already-known pre-treatments for decorative plating. Since, according to the general view, the natural oxide layer on the aluminum must be removed in order to obtain a bare metallic surface, the surface must be roughened, so that the oxide can be removed by acids or alkalis. A thin coating of metal is generally deposited at the same time as the oxide layer is removed to prevent the formation of a new layer of oxide, and this serves as a base for the chromium electrodeposit.

## Pretreatment

Methods of pre-treatment other than pickling are known:<sup>1</sup> for example, reinforcing the natural oxide layer by anodizing, followed by its cathodic removal in a suitable electrolyte, with the simultaneous deposit of a protective metal on the clean surface.

The nature of the roughening depends largely on the

composition, structure and previous history of the basis metal, so that similar pickling methods give quite different results with different materials.

The pre-pickling treatment may be either acid (generally hydrochloric or hydrofluoric) or alkaline (generally zincate).

Hydrochloric acid pickles<sup>2</sup> also contain metallic chlorides and are used both at room and higher temperatures. They attack and roughen the aluminum surface considerably, and for decorative coatings are therefore only adopted when thick coatings are required which will also give good corrosion resistance.

The pickles contain ferrous chloride, ferric chloride, nickel chloride, cadmium chloride, etc. These metals are mostly deposited on the aluminum, and in only a very few cases are they removed by pickling before the chromium plating.

For decorative coatings, alkaline pickles,<sup>3</sup> which in general cause much less roughening of the surface, are more often used. They are mainly zincate solutions, often also containing other metals such as copper,<sup>4</sup> iron,<sup>5</sup> etc., and form on the aluminum a predominantly zinc coating, which is characterized by its good adherence and so is a very suitable basis for electrodeposits.

In a variant of this process,<sup>5</sup> the chromium coating is deposited directly on to the aluminum surface after removing the metal coating by pickling: even in this case there is really no bare metal surface after pickling, but a faintly colored coating of unknown composition which does not affect the adhesion of the deposit.

Processes in which metallic coatings are deposited on the basis metal during pickling are limited in their application to the hard chromium plating of aluminum. Although the view that the metal coatings must be deposited on bare and oxide-free aluminum surfaces is widely held, surprisingly enough it has been proved that this is not the case for adherent chromium deposits.

The methods available can be divided into two groups:—

1. Direct chromium plating of aluminum without an intermediate layer.
2. With an intermediate layer deposited on the aluminum either by immersion or electrolytically.

## The DVL Process

For direct plating the method developed by the former Deutsche Versuchsanstalt für Luftfahrt, Berlin,<sup>6</sup> is very suitable. A particularly convenient method of roughening the basis metal is used, and the presence of an intermediate layer is dispensed with. The interlocking of the chromium layer into the heavily roughened and greatly increased surface means that its adhesion is at least as good as, if not better than, when an intermediate layer is used. Presumably the adhesion is due solely to this interlocking, so that a bare metal surface

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is not unconditionally necessary. Since articles which have been pre-pickled by this process can be left in the air for some hours, an oxide-free surface cannot be a necessary requisite for adhesion (which also appears to be the case when chromium plating with an intermediate layer). Omitting the intermediate layer simplifies the process considerably and makes it more reliable.

The process is very suitable for most alloys containing heavy metals and casting alloys containing silicon and copper. For alloys with magnesium and zinc the pickling must be adapted to give an even roughening of the surface.

### **Nickel Chloride Pickle**

The article is first degreased and then pre-pickled in 10 per cent caustic soda at 65°C., which forms a dark film consisting of the insoluble heavy metal constituents of the alloy. After rinsing, it is pickled in a solution containing nickel chloride, without removing this film; this roughens the surface considerably. The fairly thick film of nickel which is formed, which would prevent further roughening, is removed in nitric acid, and the article can then be chromium-plated after rinsing without further treatment.

The use of pickles containing nickel chloride for pre-pickling and roughening aluminum is not new. The essential part of the process is that after pickling in sodium hydroxide the work is not freed from the dark film, whereas this has hitherto been done by treatment with nitric acid. The DVL process utilizes the high potential difference existing between the finely dispersed heavy metals and the basis metal, to produce numerous local cells, which are uniformly distributed over the surface, independently of the structure of the basis metal, and to ensure a uniform roughening in the strongly conducting nickel solution. If necessary, the process can be repeated more than once.

The work is generally attacked quite uniformly, and appears dark grey to light grey according to the way in which the nickel film is removed. Such a surface may be chromium plated without difficulty directly after removing the nickel film in nitric acid.

Although the attack of the caustic soda and nickel chloride is very heavy, the time of pickling is so short that the aluminum suffers no appreciable change in dimensions.

Aluminum casting alloys are in general easier to chromium plate than wrought alloys. Casting defects do not affect the process.

The surface obtained by pickling in weakly diluted cold nitric acid is not metallically pure, apart from the oxide layer. It is still dark colored; small, deep-black particles, which have no effect on the adhesion of the chromium, may be seen on the surface. They can only be removed completely by pickling in hot concentrated nitric acid. When hot nitric acid is used (which is rather inconvenient for large articles) some of the residues are removed mechanically, before the deposition of the chromium, by the hydrogen developed in the chromium bath. If the aluminum is dissolved from the chromium, then only a few black spots remain on the aluminum side of the chromium coating.

The adhesion of the chromium is very good. Thin sheets may be bent after chromium plating without

peeling. DVL-plated articles will stand being heated several times to high temperatures. When thicker sheets are bent the chromium flakes off on the stressed side, together with pieces of the basis metal; the aluminum is easily detected in the peeled portions.

The good adhesion seems to be due to the close interlocking of the deposit in the uniformly roughened base.

### **Structure of Deposit**

Even very thick coatings on articles prepared by this method are smooth and free from pimples. The structure of chromium coatings is known to differ from that of other electrodeposits in some essential points; the growth of the chromium layer never follows the crystalline form of the basis metal, as do deposits of many other metals after suitable pre-etching. Under the usual conditions, it more frequently forms a very fine-grained deposit traversed by a network of fine cracks.

Since the surface of the article to be plated is never uniform in the electrochemical sense, the deposit generally grows from a few nuclei; a crystalline aggregate growing outwards from each nucleus, visible on the surface of the deposit as a flat pimple. The more uniform the surface, the more uniform is the distribution of the crystalline aggregate and thus the smoother is the coating. Surfaces roughened by the DVL process provide an almost ideal base for the formation of an even coating, owing to their uniform roughening, which is independent of the composition of the basis metal. In surfaces which have been badly pickled, the degree of previous working influences the formation of the pimples. A surface torn, for example, by sharp-edged raised abrasive particles, is an unsuitable base for a smooth coating. At the points scratched by the particles pimples of chromium are very quickly formed. These pimples may not interlock sufficiently with the neighboring deposit, and so may be torn out during machining and leave pores. Even if the pimples do not break off machining is difficult.

An evenly roughened base does not lead to the preferential growth of pimples; the crystallite aggregates are more or less the same size and are so closely interlocked that they cannot break off. The fine cracks which appear do not run around the edge of the pimples, but frequently go right through them. This network of cracks is of great importance for the adhesion of the coating under thermal stress (see below).

An insufficiently roughened surface will thus cause an unevenly pimpled and perhaps porous coating with poor adhesion, which may peel off under thermal stress, and methods of roughening which produce an uneven surface with sharp edges are not suited to plating by the DVL process. For example, surfaces pickled with caustic soda only, lead to pimpled coatings with poor adhesion, and sand-blasting produces an even but very scratched surface.

For Al-Mg and Al-Mg-Zn alloys, the DVL developed a pickle containing copper,<sup>6</sup> which gives a surface comparable to that produced by the nickel chloride solution on Al-Cu-Mg alloys. A film of copper is deposited on the aluminum surface; it does not adhere closely but flakes off as small spangles. In this case the local cells which are necessary for even roughening are formed between the partially adherent copper coating and the aluminum.

### **The FBM Process**

Of the methods using intermediate layers, the FBM process for chromium plating<sup>7</sup> was developed from the zincate pickle. It was known that metals deposited by immersion did not provide a particularly suitable intermediate layer for hard chromium plating, their adhesion being generally insufficient, and that by suitable pickling in alkaline zinc solutions the zinc coating could be removed giving a clean aluminum surface, on which the chromium could be deposited directly.<sup>5</sup> In developing the process further the two metal-containing pickles were replaced by one only, which scarcely roughens the base, because the zinc deposited from the alkaline pickle inhibits the attack. The zinc coating is removed in nitric or sulphuric acid; the thin film which remains is of great significance to the adhesion of the coating. On this film, which is not suitable for direct chromium plating, a very thin coating of copper is electrodeposited as a basis for the chromium.

Instead of this layer of copper, a somewhat thicker nickel deposit may be used, which is particularly suitable for alloys with a high percentage of magnesium and alloys containing zinc. It is not so good for copper-containing alloys. It has also proved useful for castings, when the chromium deposit does not have to be machined, since a very smooth bright coating can be obtained.

The work must first be degreased, electrolytically or in caustic soda, and rinsed; any pieces of heavy metal present are removed by pickling in nitric acid. The work is then pickled in an alkaline solution, containing iron as well as zinc, and a matte light-grey coating is formed on the surface, and removed by sulphuric or nitric acid after rinsing. The pickling may be repeated if a heavier roughening is desired. For copper plating the usual cyanide bath can be used. The chromium is deposited directly on to the layer of copper, which may be so thin as to be invisible in the microsection; the maximum thickness should not exceed 5 microns, as otherwise it does not adhere sufficiently to the pickled surface.

For casting alloys such as Silumin, the surface roughening is not particularly heavy, even after several picklings.

### **Ferrous Chloride**

Another pickling process employs a warm hydrochloric acid solution containing ferrous chloride.<sup>8</sup> The operating temperature varies with the alloy and, as might be expected, there is heavy roughening of the surface. A coating of iron is formed by immersion, and serves as a basis for the application of a thicker nickel coating followed by the chromium coating. The iron coating may also be removed by nitric acid, and nickel or chromium plating applied directly on to the aluminum. The roughening is, in general, less uniform than with the DVL process and is always considerably heavier than in the FBM process. A thick nickel coating promotes a very dense uniform chromium coating with good corrosion-resistance.

### **Choice of Method**

The method selected will depend on the use to which the article is put and on the alloy of which it is made. In considering possible applications some general

points should be taken into account, e.g., cracking of the chromium coating under thermal stress.

The coefficients of expansion of chromium and aluminium are very different, those of aluminium and its alloys being about  $20 \times 10^{-6}$  and that of chromium between  $6.6$  and  $9.6 \times 10^{-6}/^{\circ}\text{C}$ . This difference gives rise to considerable stresses in chromium-plated articles on heating. They are partially relieved by the extension of the natural fine network of cracks in the chromium. For other basis metals, e.g., iron and steel, it can be shown that no additional cracking occurs on heating to  $200-300^{\circ}\text{C}$ , but for aluminium this is not so. Hence it makes no difference whether the chromium is deposited directly on the basis metal or on to a thin intermediate layer. Cracks extending down to the basis metal arise in all cases (although there seems to be an exception to this rule for heavy nickel layers, if they are not heated too strongly). With thin layers of nickel, the cracks go right through the nickel. Additional cracks always arise on both slow and rapid cooling after heating to about  $150^{\circ}\text{C}$ .

This additional formation of cracks may be significant for adhesion and corrosion-resistance. According to previous results, the adhesion of chromium coatings should not be substantially affected by temperatures of  $250-300^{\circ}\text{C}$ , because the cracks are uniformly distributed, so that the coating as a whole can participate in the variations in expansion caused by changes in temperature. Adhesion is also good under considerable mechanical stress with simultaneous temperature changes when the original surface is heavily roughened.

For corrosion-resistant coatings, which may be subjected to temperature fluctuations, intermediate layers of, for example, nickel (which, if sufficiently thick, does not crack), are desirable in view of the considerable potential difference between the chromium and the aluminium. Then the basis metal is protected even when the chromium coating is cracked. Since the soundness of the protective layer is of great importance, it should be of a metal which remains sound. Experience with hard chromium plated aluminum articles in marine atmospheres has shown that an intermediate layer of nickel is satisfactory.

So far as is known at present, hard chromium deposits have no essential influence on the properties of aluminum. While, for example, the strength of iron and steel is decreased by hard chromium plating owing to hydrogen absorption, no such effect has, in general, been found for aluminum.

Commercial hard chromium bath compositions are not all equally suitable for use with the different methods of pretreatment. For direct chromium plating of aluminium, solutions containing sulphuric acid only as catalyst are preferred, although the current density and hence the thickness of the deposit obtained in a given time are less. The concentration of  $\text{CrO}_3$  is not, however, critical. Plating can be carried out with equal ease in heavy or light chromium baths. The usual commercial  $\text{CrO}_3$  concentrations of  $150-440$  gm/L are quite satisfactory; average concentrations of  $250-350$  gm/L give good throwing power and current efficiency.

Various solutions are needed for pretreatment in processes using intermediate layers. Chromium baths  
(Concluded on page 64)

# Complex Compounds in Industrial Electroplating-Part 1

By Seymour Senderoff, Chemist, National Bureau of Standards



IN the last 50 years there has been a tremendous number of publications on matters related to complex compounds, in which their synthesis, stereochemistry, reactions, and stability have been discussed. Unfortunately, these papers have, with a few exceptions, been largely academic in nature; as a result, the application of this knowledge to industrial practices has been very slow. In the industries where the chemistry of complex compounds has been of great importance, most of the work is still highly empirical and those interested in obtaining specific results are usually satisfied when they get them, and seldom consider the reactions, equilibria or basic theory involved in their processes.

This is especially true in the electroplating industry. This is an industry which has been using complex compounds industrially since 1840, and which today operates with the great majority of its processes based on complex compounds, and with most of the others using complex constituents for one purpose or another. It would therefore be desirable to review the plating processes with special attention to their complex constituents, to collect the results of the lamentably few fundamental studies in this field, and especially to point out the unanswered questions and controversy which exist in even the most widely used and best standardized plating systems. Considerations of space as well as basic interest require that we limit ourselves in this review almost entirely to those systems which have attained appreciable application in industry.

In the search for improved plating processes, metal salts have been mixed with almost every conceivable complexing agent, and the solutions electrolyzed. In many cases deposits are obtained; but if they are no better than those obtained from existing systems, the work is dropped. It would be pointless to review these methods except in a few cases of special interest. We will therefore confine ourselves to the electrodeposition of the 12 metals and 3 alloys which are regularly plated industrially, and (with a few exceptions) only to those systems which have found industrial application.

## The Nature of Complexes

Before entering into a discussion of the various plating solutions, let us consider briefly the general subject of complex compounds. In its broadest sense a complex compound is one in which saturated molecules

capable of independent existence are joined in a definite stoichiometric ratio to form a new compound. Many compounds of this type are stable only in the solid state. When dissolved in water, compounds such as alum,  $K_2Al_2(SO_4)_4 \cdot 24H_2O$ , or the double nickel salt,  $Ni(NH_4)_2(SO_4)_2 \cdot 6H_2O$ , are dissociated into the simple ions and are indistinguishable from a solution of a mixture of the simple salts. On the other hand, solutions of compounds such as  $KAg(CN)_2$ , or  $[Ni(NH_3)_6]SO_4$  (which is prepared by adding an excess of  $NH_4OH$  to a solution of  $NiSO_4$ ) exhibit properties widely different from those of solutions of the simple metal salts. They frequently differ in color, in reactions, and most important in electroplating, in their oxidation-reduction potentials. The first group, which are stable in the solid state only, are called "lattice" compounds, and will not be considered any further in this discussion. In compounds of the second group the bonding between some of the atoms and molecules in the compound is sufficiently strong to maintain the complex structure in water solution. These are called "coordination" compounds, since it has been shown that the chemical bond which characterizes these compounds is the coordinate bond. The coordination compounds, like all other chemical compounds, vary in the stability of their structure, and their stability has been characterized in terms of two limiting types. The first type is that in which the complex ion reversibly dissociates into its constituents, e.g.



In such a case the concentration of the metal ion in solution is determined as in all equilibria by the mass law, i.e.

$$K = \frac{[Zn^{2+}][CN^{-}]^4}{[Zn(CN)_4]^{2-}}$$

where "K" is the instability constant of this complex ion. This type of complex is called a "normal" complex. The other limiting type is that in which there is no evidence of any dissociation. The ferrocyanide ion,  $[Fe(CN)_6]^{4-}$  is a complex ion of this type. In this case there is no detectable concentration of  $Fe^{2+}$  in solution, any more than there is any carbon concentration detectable in a solution of acetate ion. The type of complex represented by  $[Fe(CN)_6]^{4-}$  is called a "penetration" complex. It should be emphasized that these are limiting cases and that there is not a distinct separation of types. Actually the coordinate bond, in which the shared pair of electrons forming the bond is derived from only one atom, is an intermediate form between the electrovalent and covalent bonds, and coordination compounds in solution vary in their stabil-

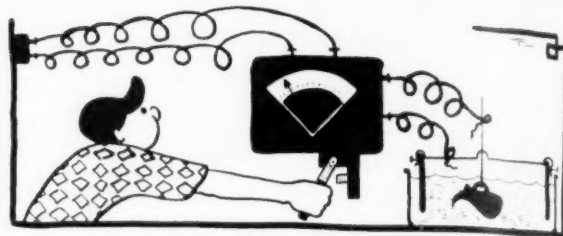
ity between these two forms. Both types are used in plating solutions. When the metal to be plated appears in the complex ion, it is usually in a "normal" complex. When addition agents form complexes, the "penetration" type is frequently obtained. Examples of both types will appear later in the discussion.

Another characteristic of complex compounds is the identification of a specific coordination number with each metal ion. The coordination number is the number of groups (ions or molecules) which may be arranged around the central ion to give stable spatially symmetrical arrangements. This number is found to be 2, 4, 6, or 8 for most ions, with 4 and 6 most usual. It is generally believed that in solution an ion is coordinated with the number of groups required by its coordination number. Potentiometric titrations, analyses of solutions, and solubility measurements frequently indicate compositions that are not in accord with the coordination number if only the added complexing agent is considered. It is known, however, that water forms coordinate bonds with ions, and it is likely that in these cases water is coordinated to make up the difference. There is evidence for the existence in solution of a complex ion containing 3 moles of (CN) to one of Cu and one containing 2 moles of (CN) to one of Cu. Since the coordination number of  $\text{Cu}^+$  is 4, the tricyano- ion is probably  $[\text{Cu}(\text{H}_2\text{O})(\text{CN})_3]^{2-}$  and the dicyano- complex is probably  $[\text{Cu}(\text{H}_2\text{O})_2(\text{CN})_2]^-$ . In many cases the aquated ions can be precipitated as salts and their composition confirmed. It should be noted, however, that the existence of a material in the solid state is not, of itself, conclusive evidence of its existence in solution, since in the process of precipitation, changes in composition may occur. In most cases, the ratio of metal to complexing agent is all that is determined experimentally, and hence the ions are written without including the coordinated water. E.g. the tricyano- and dicyano- complexes are written  $[\text{Cu}(\text{CN})_3]^{2-}$  and  $[\text{Cu}(\text{CN})_2]^-$  respectively. When this practice is followed, as in this paper, it will be understood that no variable coordination number is implied, but rather that coordinated water is ignored.

### Functions of Complexes in Plating

Complex compounds have three major functions in plating solutions. First, a complex compound may be the major source of the metal which is being plated. In this first category are found two distinct types. In one, the metal ion itself is part of a complex anion or cation and its electrodeposition involves the decomposition of the complex ion. Typical of this group are the cyanide complexes, and stannates. In the second group the compound in solution gives a simple metal cation and a complex anion. Such compounds are used when no easily available simple salt is sufficiently soluble or stable in water, and also when the anion of the complex compound provides desirable properties to the plating solution that are not obtainable with simple salts. Examples of this group are the fluoborates and fluosilicates.

The second major function of complex compounds in plating solutions is to serve as "addition agents." In most cases complexing agents are added to the solution and the complex compounds are formed *in situ*. The purposes for which these materials are added are



many and varied. They may (1) improve anode corrosion, (2) improve the physical properties of the deposit, (3) act as brighteners, and (4) reduce sensitivity to impurities or remove them from the solution. In addition, necessary or accidental components of the plating solution may form complex compounds which render plating more difficult, or interfere with deposition of the metal. Such products of necessary constituents, or unavoidable impurities in the plating solution, must be very well understood and carefully controlled for successful plating.

The third major function of complex compounds is the control of the deposition potential of the metal. While this is important in all electroplating, it has particular significance in the electrodeposition of alloys. Metals whose deposition potentials in a given system are very far apart cannot be codeposited. By proper formulation of plating solutions with the metals in appropriate complex ions, many alloys can be and have been deposited with extremely accurate control of both the composition and color.

In the discussion of the individual plating systems which follows, examples will be found of each of these functions and uses of complex compounds.

### Complexes in Copper Plating

Copper has been plated in industry from 5 general systems: the sulfate, cyanide, pyrophosphate, fluoborate, and diethylene triamine systems. Since so many different processes are used it is clear that each must have its advantages and disadvantages and that the solution is used which gives the best combination of properties for a given application. The  $\text{CuSO}_4$  solution is the only one of these that is not based on a complex system, although in recent years addition agents have been used in this solution whose action may be based on their complex-forming properties.

We shall first consider the cyanide solutions, which consist of three types: the conventional cyanide solution, the Rochelle-cyanide solution, and the high-speed cyanide bath. There are a number of reasons for the use of the more expensive cyanide solutions in preference to the simpler sulfate baths. When plating from the latter on steel, zinc-base die castings or any metal above copper in the electromotive series, copper will deposit on the base metal by displacement. This invariably results in non-adherent deposits. Iron and zinc do not displace copper when they are immersed in the cyanide copper solution because in the presence of cyanide, copper is displaced upward in the E.M.F. series, i.e. it becomes less noble than the usual base metals. The equilibrium reduction potential of copper in cyanide plating solutions has been reported to be about  $-0.5$  to  $-0.06\text{V}$  ( $\text{H}_2$  scale)<sup>1</sup> while the standard reduction potential of  $\text{Cu}^{2+}$  is  $+0.34\text{V}$ . This effect may

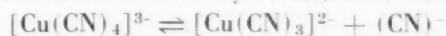
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be due to the reduction of the copper ion concentration to the very low value indicated by the instability constant of the complex ion involved,<sup>2</sup> or to the deposition potential of the complex ion itself.<sup>3, 4, 5</sup>

Another important property of cyanide copper plating solutions is their good throwing power. The throwing power of a solution is most closely associated with the form of its cathode polarization curve, which is intimately connected with the cyanide content of the solution.<sup>6</sup>

Although cyanide copper plating solutions have been in use for over 50 years, and over a hundred papers have been written during this time on their constitution, it must be admitted that we still do not understand either the mechanism of copper deposition or the nature and concentration of the various complex ions present. It is generally agreed that the copper is present largely as  $[\text{Cu}(\text{CN})_3]^{2-}$ , though some  $[\text{Cu}(\text{CN})_2]^-$  and  $[\text{Cu}(\text{CN})_4]^{3-}$  are also present.<sup>7</sup> Excess cyanide lowers the cathode efficiency and raises the polarization, while an increase in temperature, within limits, has the opposite effect. These facts would indicate that the effect of higher cyanide concentration is to cause a shift to the tetracyano complex, and that of higher temperature, to the dicyano complex.<sup>6</sup> A number<sup>1, 8</sup> of investigators have found that increase of both copper and cyanide, in the ratio that they are present in the tricyano complex ion, increases both anode and cathode efficiency and decreases both anode and cathode polarization. This can be explained only by considering the  $[\text{Cu}(\text{CN})_3]^{2-}$  ion as a source of both copper and cyanide, by a conversion to the dicyano form with increasing concentration. It should be emphasized that the values determined for "free cyanide" and "combined cyanide," though important in the control of plating solutions, have little reference to the real composition of the solution. When one determines "free cyanide" by the standard procedure of titrating with  $\text{AgNO}_3$  with KI as indicator, all one finds is how much cyanide is less tightly bound in the copper plating solution than in the  $[\text{Ag}(\text{CN})_2]^-$  complex ion. The end-point of this titration occurs when the solubility product of AgI is exceeded. Taking  $K_{sp}$  of AgI as  $1.7 \times 10^{-16}$  and the concentration of  $\text{I}^-$  as  $10^{-2} \text{ M/l}$ , the concentration of  $\text{Ag}^+$  at the end point is approximately  $2 \times 10^{-14} \text{ M/l}$ . With  $K_{inst}$  of  $[\text{Ag}(\text{CN})_2]^-$  equal to  $4 \times 10^{-22}$  (Ref. 9) and assuming a molar conc. of this ion, the  $(\text{CN})^-$  concentration at the end point of this titration is approximately  $10^{-4} \text{ M/l}$ . It is clear, as Thompson<sup>10</sup> has shown, that the value of free cyanide obtained depends on the amount of indicator used. Certainly more must be known about the instability constants and reactions in the cuprocyanide system before one can say definitely that, at this arbitrary value of  $(\text{CN})^-$  concentration, one has separated the "free" from the combined cyanide. Although the tetracyano complex is known to be present when excess cyanide is present in the bath, this titration seems to dissociate it into the tricyano complex and  $(\text{CN})^-$ . It is interesting in view of this to note the categorical statement in a standard textbook<sup>11</sup> that the  $[\text{Cu}(\text{CN})_3]^{2-}$  is less stable than the  $[\text{Cu}(\text{CN})_4]^{3-}$ . The instability constant usually given for the tetracyano complex is  $5 \times 10^{-28}$  (Ref. 10), an even lower value than that for  $[\text{Ag}(\text{CN})_2]^-$ , but this

refers to the reaction  $[\text{Cu}(\text{CN})_4]^{3-} \rightleftharpoons \text{Cu}^+ + 4(\text{CN})^-$ . The reaction which evidently occurs, however, is



for which reaction the instability constant is probably higher.

The conventional cyanide copper bath is made up by dissolving cuprous cyanide, sodium cyanide, and sodium carbonate in water. It is used mainly for "strike" plating and other incidental copper plating. When used as a strike solution, the metal content is usually low and the free cyanide high. Under these conditions, the efficiency and limiting current density are low, but the throwing power is high, which is advantageous for a strike. Because of its low efficiency and low limiting current density it takes a long time to apply a thick plate with this solution. To increase its plating speed, a slightly higher metal content and lower free cyanide were used at somewhat higher temperatures,<sup>12</sup> but difficulties were encountered with anode corrosion. The addition of Rochelle salts<sup>13</sup> to this modified solution improved the anode corrosion and resulted in the widely used Rochelle-cyanide solution.

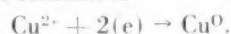
The action of the tartrate is believed to be the temporary formation of complex ions by reaction with the products of electrolysis in the anode film. It is possible that the tartrate dissolves cupric compounds, which may form at the anode at high current density,<sup>6</sup> or that it forms complex ions with basic salts that may exist in the cathode film.<sup>7</sup>

In the "high-speed" cyanide copper solution,<sup>14</sup> the tartrate is dispensed with, the copper concentration is increased to about 5 times that of the Rochelle-type, and the free cyanide is reduced to 1/10 its value in the Rochelle bath. Much faster plating is obtained as a result of the higher limiting current density and the practically 100% cathode efficiency. The loss in desirable plating properties resulting from the reduction of free cyanide is counteracted by vigorous agitation of the solution and by high operating temperatures (85°C.). It is likely that the high temperature dissociates the tricyano complex into the dicyano copper ion, thereby producing free cyanide, which would not show up in the titration at room temperature. The reduction potential of copper in this solution has been lowered to the point where a tendency exists for copper deposition by displacement on the more active metals, hence it is necessary to use one of the other types of cyanide solutions as a strike. The low free cyanide in this solution either allows the copper ion concentration to increase appreciably, or the high temperature and low cyanide together induce a basic change in the complex constitution of the solution (e.g.  $[\text{Cu}(\text{CN})_2]^-$  becomes the dominant ion), thus changing the deposition potential. Organic addition agents are used in this solution.

A number of brighteners with complex-forming properties have been used in the acid-sulfate and the cyanide copper solutions. While little is understood about the action of brighteners, many of them are strong complex-forming agents, and it is likely that this property affects their behavior. This subject will be discussed in greater detail under nickel plating where brighteners have become extremely important, but at this point it may be well to identify some of the materials which have found use as copper brighteners. In

the acid copper solution a mixture of molasses and thiourea<sup>19</sup> has been widely used. Also, acetyl cyanamid,<sup>20</sup> sulfurized and sulfonated aromatic hydrocarbons,<sup>21</sup> tri-isopropanolamine,<sup>22</sup> and a number of proteins have been used. In the cyanide copper solutions, NaCNS and sucrose,<sup>23</sup> acetyl or benzoyl thiophene,<sup>24</sup> and many others have been used. It will be seen that a large number of active agents contain nitrogen or sulfur, which is true of brighteners in most plating systems.

Another system for the deposition of copper is based on the copper-pyrophosphate complex.<sup>15</sup> The high alkalinity and cyanide content of the cyanide copper solutions render them irritant and poisonous. The pyrophosphate solution is neither corrosive nor poisonous, and is said to have the desirable throwing power of the cyanide solutions. The solution is only slightly alkaline (pH 7.5-9.5) and produces extremely smooth and ductile copper deposits at a fairly high rate of deposition. The pyrophosphate copper is prepared by dissolving  $\text{Cu}_2\text{P}_2\text{O}_7$  in a solution of  $\text{K}_4\text{P}_2\text{O}_7$ , with the molar ratio of  $\text{P}_2\text{O}_7$ :Cu slightly in excess of 2:1. In addition, the solution contains two subsidiary complexing agents, citrate and  $\text{NH}_3$ . The major complex ion present is  $[\text{Cu}(\text{P}_2\text{O}_7)_2]^{6-}$ , and on slow evaporation blue crystals of hydrated  $\text{K}_6\text{Cu}(\text{P}_2\text{O}_7)_2$  may be isolated. Physicochemical studies have shown that there is also present  $[\text{CuP}_2\text{O}_7]^{2-}$  (Ref. 16). The pyrophosphate-copper system is one of intermediate stability. The reduction potential of copper from this system is raised to about the level of the standard hydrogen reduction potential, but increasing the  $\text{P}_2\text{O}_7$ /Cu ratio to any practical level will not make the copper less noble than iron in this system. It is therefore necessary to use a strike plate from a cyanide copper solution before plating with pyrophosphate-copper. The intermediate stability of the complex is demonstrated in another way. At pH values appreciably below 7,  $\text{CuH}_2\text{P}_2\text{O}_7$  or  $\text{Cu}_2\text{P}_2\text{O}_7$  precipitates, and above pH 11,  $\text{Cu}(\text{OH})_2$  precipitates. Acidification below pH 7 evidently converts the  $[\text{P}_2\text{O}_7]^{4-}$  to  $[\text{H}_2\text{P}_2\text{O}_7]^{2-}$  and thus destroys the complex ion.<sup>17</sup> Above pH 11 the concentration of  $(\text{OH})^-$  is sufficiently high to exceed the solubility product of  $\text{Cu}(\text{OH})_2$  with the concentration of  $\text{Cu}^{++}$  that is available from the dissociation of the complex. Within the designated pH range the complex is quite stable, as is evidenced by the very slight hydrolysis of  $[\text{P}_2\text{O}_7]^{4-}$  to  $[\text{PO}_4]^{3-}$ , which would ordinarily occur at a fairly rapid rate at the temperature and pH at which the solution operates.<sup>18</sup> The citrate, while mainly added as a buffer, also acts to aid anode corrosion by forming complex ions with copper. The  $\text{NH}_3$ , present in concentrations of about 1 g/l, has favorable effects on anode corrosion but an unfavorable cathode effect. Unlike in the cyanide system, the copper in this system is divalent. At normal operating voltages the cathodic reaction is



At a very low voltage, however, (0.1 — 0.2V) the reaction



may occur, which is undesirable, since under such conditions  $\text{Cu}_2\text{O}$  might deposit on the cathode. The potential at which this intermediate reduction step occurs increases with the concentration of ammonia; hence at

high concentrations of  $\text{NH}_3$ , the  $\text{Cu}^{2+} \rightarrow \text{Cu}$  reaction might conceivably occur at nearly the normal operating voltage. It is therefore necessary in defining the proper concentration of  $\text{NH}_3$  in the solution to balance its desirable effects on anode corrosion and brightening action, with its undesirable cathode effect. Another desirable effect of an excess of  $\text{NH}_3$  is to increase the rate of hydrolysis of the  $[\text{P}_2\text{O}_7]^{4-}$ , probably by displacing it from the copper complex. The pyrophosphate-copper solution has found wide application in industry, both in general copper plating and in those applications, such as plating on active metals, where the non-corrosiveness of the solution is especially required.

Another type of copper plating system that has recently attained general acceptance is the copper fluoborate solution. Here the copper is present as a simple cupric ion, but the anion is the complex  $(\text{BF}_4)^-$ . Considering the availability and solubility of  $\text{CuSO}_4$ , the use of a complex anion bath for copper might seem surprising. However, it is claimed<sup>25</sup> that higher limiting current densities and smoother deposits are obtained with the fluoborate solution. Further, higher metal concentrations can be used, thereby even further increasing the maximum plating rate. It is difficult to see how the anion can affect the limiting current density, which is determined, for a first approximation, by the equation<sup>26</sup>

$$I_1 = \frac{\text{DnF}}{\text{td}}, \text{ a.}$$

which is the limiting case of:

$$I = \frac{\text{DnF}}{\text{td}} (a - a_c),$$

where  $I$  = current density

$I_1$  = limiting current density

$D$  = diffusion coefficient of metal ion

$n$  = valence of the metal ion

$F$  = Faraday

$t$  = sum of transference numbers of all ions in the diffusion layer other than those being discharged

$d$  = thickness of diffusion layer

$a$  = activity of the metal ion in the bulk of the solution

$a_c$  = activity of the metal ion at the cathode surface

In order to raise the limiting current density when  $a$  and  $d$  are constant, one must increase the diffusion coefficient of the metal ion, or decrease the transference number of all the other ions, i.e. increase the transference number of the metal ion. An indication of the extent to which either of these is accomplished is obtained by measuring the metal concentration in the solution immediately adjacent to the cathode at current densities below the limiting value. Such measurements were made on copper sulfate and fluoborate solutions, by the author<sup>27</sup> using the drainage technique of H. E. Haring.<sup>28</sup> It was found that with solutions of the same copper concentration and at the same pH at 4 amp/dm<sup>2</sup>, the value of  $(a - a_c)$  in the fluoborate plating solution was  $\frac{1}{2}$  that of the sulfate bath. It is clear, then, that either the diffusion coefficient or the transference number of  $\text{Cu}^{2+}$  is higher in the fluoborate system than

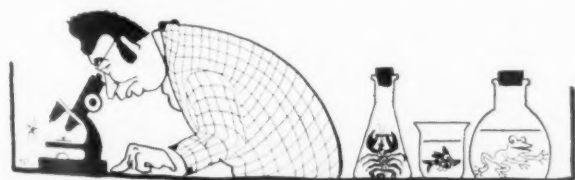
in the sulfate system. It is hard to explain either possibility. It has been generally believed that the transference number of copper in the sulfate plating bath is close to zero, since with the high concentration and high mobility of  $H^+$ , the latter carries almost all the current. As both solutions were run at the same pH, the transference number of the  $Cu^{2+}$  should have been close to zero in either case. A determination with a  $CuSO_4$  solution at a pH of 2.6 still gave a value of ( $a-a_c$ ) 50% higher than a fluoborate solution at a pH of 0.5, indicating that the transference number of  $Cu^{2+}$  in these systems is not the major difference that accounts for the higher limiting current density obtainable in fluoborate systems. The effect of the change of anion seems to be mainly on the diffusion coefficient of the  $Cu^{2+}$ . This cannot be readily explained and is one of many examples of peculiar effects of anions in plating solutions. Examples of anion effects have been discussed by Mathers and others.<sup>29</sup>

The last copper plating system to be considered is the diethylene-triamine-copper. The solution is prepared by mixing  $CuSO_4$ , diethylene triamine and  $(NH_4)_2SO_4$ .<sup>30</sup> It is alkaline, is operated at elevated temperatures and probably contains both the  $[Cu(NH_3)_4]^{2+}$  and the  $[Cu(\text{diethylene triamine})_2]^{2+}$  ions. It is especially interesting in that it is the only ammine- or substituted ammine-complex system which has attained industrial use in the plating industry, although this particular type of complex has been the subject of more theoretical study than any of the other types of complex compounds. Electrodeposits are obtainable from other ammine-systems, but in most other cases they are inferior to, or more difficult to operate than existing methods. The copper deposits from this system are said to be of high quality and brightness and capable of being rapidly deposited.

### Complexes in Nickel Plating

Practically all nickel deposited industrially (with the exception of a single special application to be discussed later) is plated from the simple  $NiSO_4$  solution. Some solutions containing  $NiSO_4 \cdot (NH_4)_2SO_4$  are still used in making electrotypes, but this is also a simple salt solution under the meaning of the term used here, since no complex ions are present in solution. The usual solution contains  $NiSO_4$ ,  $NiCl_2$ , and  $H_3BO_3$ . As such it would be of no interest in a paper on complex compounds in electroplating, but in recent years the plating of bright nickel has reached such great importance that literally hundreds of papers and patents have been published on such solutions. The solution described above plus addition agent(s) makes a bright nickel bath, and it is the addition agents that concern us here. There are two major theories that attempt to explain the action of addition agents in plating solutions. One may be characterized as the adsorption theory<sup>31</sup> in which it is believed that colloids or ions are adsorbed on the cathode, and thus interfere with normal crystal

growth; the other is the complex ion theory,<sup>32</sup> which postulates the formation of complex anions or cations which are electrically discharged together with the metal being deposited, and so interfere with normal crystal growth. No decision can be reached on the basis of present knowledge as to which of these is the more correct. Very possibly both operate under different conditions and sometimes both may operate together. One of the difficulties in pinning down the mechanism by which brighteners work is the extreme specificity of their action. It is very difficult to discern homologous series or trends among brightening compounds. A study of over 100 compounds more or less effective as addition agents in nickel plating showed no clear relation between the structure of the organic molecules and their brightening action.<sup>33</sup> On briefly examining those compounds which have been found to be effective as brighteners in nickel plating we find that almost all of them are of the type that form complex compounds with metals. Compounds<sup>34</sup> such as sulfonamides, sulfonimides, sulfimides, triaryl methanes, aromatic amines, aldehydes and ketones, sulfonic acids and sulfones all have been used as nickel brighteners. Unfortunately, a single member of each of these groups of compounds may be very effective, while slightly different compounds of the same type show little or no benefit. However, those compounds containing nitrogen and sulfur, frequently with oxygen in an ideal position for coordination to form ring compounds, certainly can be expected to form complex anions, cations, or neutral molecules, whether this property is important in the mechanism of their brightening action or not. There is some evidence that the complexes formed in the bath are important in their action. Many brighteners operate only within specific ranges of current density, so that it is frequently necessary to use more than one brightener in a solution to cover the entire plating range. While adsorption may vary with potential, the sharpness of the "cut-off" on some of these materials indicates the possibility of their being discharged at a specific potential. It has been argued that the extremely low concentration in which these materials are used indicates the likelihood of a surface reaction. However, it is known that at the correct potential, cathode effects sufficiently definite to be used for quantitative measurements are obtained with materials present in concentrations as low as  $10^{-5}$  M/l. It has been shown that many brighteners for nickel have surface-active properties. However, these materials are frequently weak brighteners. Their most effective use is together with other brighteners whose activity they enhance. This relation would seem to indicate that both adsorption and complex formation are important in brightener action. This is not surprising, since many of these brightening agents would tend to form colloidal insoluble materials or heavy, easily-adsorbed neutral molecules. Where this occurs, adsorption may be a vital process in the activity of these colloidal complexes, but when the complexes formed are ions, they may be either electrically discharged or adsorbed. The fact remains, however, that those materials with brightening action, not only in nickel, but in copper (as we have already seen) and in most other plating solutions, are also those with a great tendency to coordinate with metal ions.





Another important effect of addition agents, which almost certainly depends on their complex-forming properties, is the sequestering of metallic impurities. Unsaturated aliphatic sulfonamides or sulfonimides increase the tolerance of bright nickel solutions to Zn, Cd, Tl, Hg, Cu.<sup>34d</sup> Dithiocarbamates, benzothiazoles, and other sulfur-containing compounds which form chelates (ring-compounds) with metals, have been used for sequestering or precipitating heavy metals in other solutions. This action is particularly important in bright plating, since these solutions are usually very sensitive to impurities. Frequently a "brightener" acts as such entirely as a result of its removal of metal impurities from a solution; impurities present in so low a concentration that their presence was not even suspected, and hence the real nature of the brightener's action was missed. In addition, many brighteners have profound effects on the physical properties of the deposit. Saccharine, for instance, a powerful brightener in nickel solutions, is also considered a "ductilizer." Actually, it reduces and may even eliminate the stress inherent in nickel coatings.<sup>35</sup> It is very likely that attempts to isolate and study the complex compounds formed by brighteners in plating solutions will throw much more light on the mechanism of addition agent action.

There is one nickel solution based on complex salts which has found some industrial application in the plating of zinc-base die-castings. It is a slightly alkaline solution containing  $\text{NH}_3$ , pyrophosphate, and citrate,<sup>36</sup> all of which form complex ions with nickel. It is especially effective in covering recesses in the die-castings, so that when they are immersed in a subsequent plating solution, the zinc does not dissolve and contaminate the solution.

(To be continued)

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#### Bibliography

1. J. V. Petrocelli, *Trans. Electrochem. Soc.*, **77**, 133 (1940).
2. F. Spitzer, *Z. Elektrochem.*, **11**, 345, 391 (1905).
3. F. Haber, *Z. Elektrochem.*, **10**, 433, 773 (1904).
4. G. Bodlander, *Z. Elektrochem.*, **10**, 604 (1904).
5. F. Foerster, *Elektrochemie Wasseriger Losungen*, 3rd Ed., p. 299, footnote 1, J. A. Barth, Leipzig (1922).
6. M. R. Thompson, *Trans. Electrochem. Soc.*, **79**, 417 (1941).
7. A. K. Graham and H. J. Read, *Trans. Electrochem. Soc.*, **80**, 344 (1941).
8. H. J. Read and A. K. Graham, *Trans. Electrochem. Soc.*, **74**, 411 (1938).
9. H. T. S. Britton and E. N. Dodd, *J. Chem. Soc.*, p. 1940 (1932).
10. M. R. Thompson, *Month. Rev. Am. Electroplaters' Soc.*, **18**, No. 5, 31 (1931).

11. H. J. Emeleus and J. S. Anderson, *Modern Aspects of Inorganic Chemistry*, p. 143, D. Van Nostrand, N. Y. (1938).
12. L. C. Pan, *Trans. Electrochem. Soc.*, **68**, 471 (1935).
13. J. F. K. McCullough and B. W. Gilchrist, U. S. Pat. 1,863,869.
14. H. L. Brenner and C. J. Wernlund, *Trans. Electrochem. Soc.*, **80**, 355 (1941).
15. J. E. Stareck, U. S. Pat. 2,250,556; 2,437,865.
16. B. C. Haldar, *Science and Culture*, **14**, 340 (1949).
17. I. M. Kolthoff, *Pharm. Weekblad*, **57**, 474 (1920).
18. R. N. Bell, *Ind. Eng. Chem.*, **39**, 136 (1947).
19. F. R. Keller, U. S. Pat. 2,462,870.
20. H. Brown, U. S. Pat. 2,455,554.
21. J. A. Hendricks, U. S. Pat. 2,424,887.
22. A. M. Max and C. M. Vance, U. S. Pat. 2,482,354.
23. C. J. Wernlund, et al. U. S. Pat. 2,287,654; 2,347,448.
24. K. S. Wilson and D. G. Ellis, U. S. Pat. 2,471,918.
25. C. Struyk and A. E. Carlson, *Month. Rev. Am. Electroplaters' Soc.*, **33**, 926 (1946).
26. S. Glasstone, *Introduction to Electrochemistry*, p. 449, D. Van Nostrand, N. Y. (1942).
27. Unpublished data from the National Bureau of Standards.
28. A. Brenner, *Proc. Am. Electroplaters' Soc.*, p. 95 (1940).
29. F. C. Mathers, *Proc. Am. Electroplaters' Soc.*, p. 134 (1939).
30. L. Greenspan, U. S. Pat. 2,195,454.
31. W. Blum, *Trans. Electrochem. Soc.*, **23**, 266 (1913); **80**, 249 (1941).
32. F. C. Mathers, *Trans. Electrochem. Soc.*, **29**, 417 (1916); **36**, 234 (1919); **38**, 133 (1920) and ref. 29.
33. E. Raub and M. Wittum, *Z. Elektrochem.*, **46**, 71 (1940).
34. (a) W. L. Pinner, K. G. Soderberg, and E. M. Baker, *Trans. Electrochem. Soc.*, **80**, 539 (1941).  
(b) R. Lind, W. J. Harshaw, K. E. Long, U. S. Pat. 2,198,268; 2,238,861.  
(c) H. Brown, U. S. Pat. 2,467,580.  
(d) H. Brown, Brit. Pat. 614,014.
35. A. Brenner and S. Senderoff, *Proc. Am. Electroplaters' Soc.*, p. 67 (1948).
36. R. L. Tuttle, U. S. Pat. 2,069,566.

#### HARD CHROME PLATING

(Concluded from page 58)

with complex fluorides added are preferable, as they give higher current densities and thicker deposits. Thicknesses of up to 0.04 mm/hr can be obtained with a current density of 45-50 amp/dm<sup>2</sup>. After roughening by, for example, the DVL process, and then depositing a very thin layer of copper or nickel, a hard chromium bath containing fluorides may be used, in order to take advantage of the higher current density.

Only a brief indication can be given of the numerous applications of hard chromium-plated aluminium. It is particularly useful for highly stressed bearing surfaces where good wear-, temperature- and corrosion-resistance are required. It can be used in place of steel for all purposes for which the strength of aluminium or its alloys is sufficient, but where its poor wear-resistance has hitherto prevented its application.

#### References

1. German Patents 606,850; 601,689; 611,643; 631,371; 632,032; Travers, *Trans. Electrochem. Soc.*, 1939, 75, 201. *Light Metals*, 1938, 7, 368.
2. E.g., British Patent 438,228, etc. See also *Galvano*, 1934, 3, 13.
3. Altmannsberger, "Neuzeitliche Galvanische Metallveredlung" (Coburg, 1935), p. 58; *Metallw. Ind. u. Galvanotechn.*, 1931, p. 501; German Patent 633,091.
4. German Patents 663,979; 673,339; 668,454.
5. German Patent 633,091.
6. Beerwald, *Aluminium*, 1941, 23, 149.
7. F. Blasberg, German Patent Application B184,755 48a.
8. E.g., British Patent 476,720.

# Electroplating Bright, Hard Nickel-Phosphorus or Cobalt-Phosphorus Alloys

A COMMERCIALY feasible method for producing electrodeposits of cobalt or nickel alloyed with as much as 15 per cent of phosphorus has been developed by Abner Brenner, Dwight E. Couch, and Eugenia K. Williams of the National Bureau of Standards. The new phosphorus alloys are more easily deposited than chromium and are very hard, corrosion-resistant, and bright. They should thus be of value for many of the applications in which chromium plate is now used to obtain a hard, wear-resistant surface or a decorative finish.

Plating baths for depositing the phosphorus alloys are rather simply prepared, consisting of common nickel or cobalt salts such as the sulfate or chloride, to which is added phosphorus acid as a source of phosphorus in the deposit. See Table 1. The baths are operated at a low pH, between 0.5 and 1.5, depending on the composition. To maintain the desired acidity in the cathode film, the solution must be buffered. The Bureau has found that phosphoric acid is one of the best chemicals for this purpose. The plating baths are kept at 75°C or above because at room temperature the cathode current efficiency is very low and the deposits are weak. Current densities should be between 5 and 10 amperes per square decimeter. At the usual current density — about 10 amperes per square

(Abstracted from the *Journal of Research of the National Bureau of Standards* 44, 109, (1950).

**Table 1**  
*Composition of typical plating bath for depositing alloys of phosphorus with cobalt or nickel*

TYPE OF BATH*	NiSO <sub>4</sub> ·6H <sub>2</sub> O (g/l)	NiCl <sub>2</sub> ·6H <sub>2</sub> O (g/l)	H <sub>3</sub> PO <sub>4</sub> (100%) (g/l)	H <sub>3</sub> PO <sub>3</sub> (100%) (g/l)	CoCl <sub>2</sub> ·6H <sub>2</sub> O (g/l)
Low-phosphorus nickel .....	175	50	50	1.3	—
High-phosphorus nickel* .....	150	45	50	40	—
Low-phosphorus cobalt .....	—	—	50	1.3	210
High-phosphorus cobalt† .....	—	—	50	40	180

\*It is very important that the pH of the baths listed be less than 1.0.

†The pH of the high-phosphorus baths should be raised to a value between 0.5 and 1.0 by adding nickel or cobalt carbonate.

decimeter — the rate of deposition is fairly high, amounting to a few thousandths of an inch an hour.

## Brightness

The appearance of the deposits depends upon their phosphorus content. Alloys with less than 2 per cent of phosphorus are usually smooth with a matte finish, but as the percentage of phosphorus increases, they become brighter, reaching a peak of brightness at a phosphorus content of about 10 per cent. When such

(Concluded on page 67)

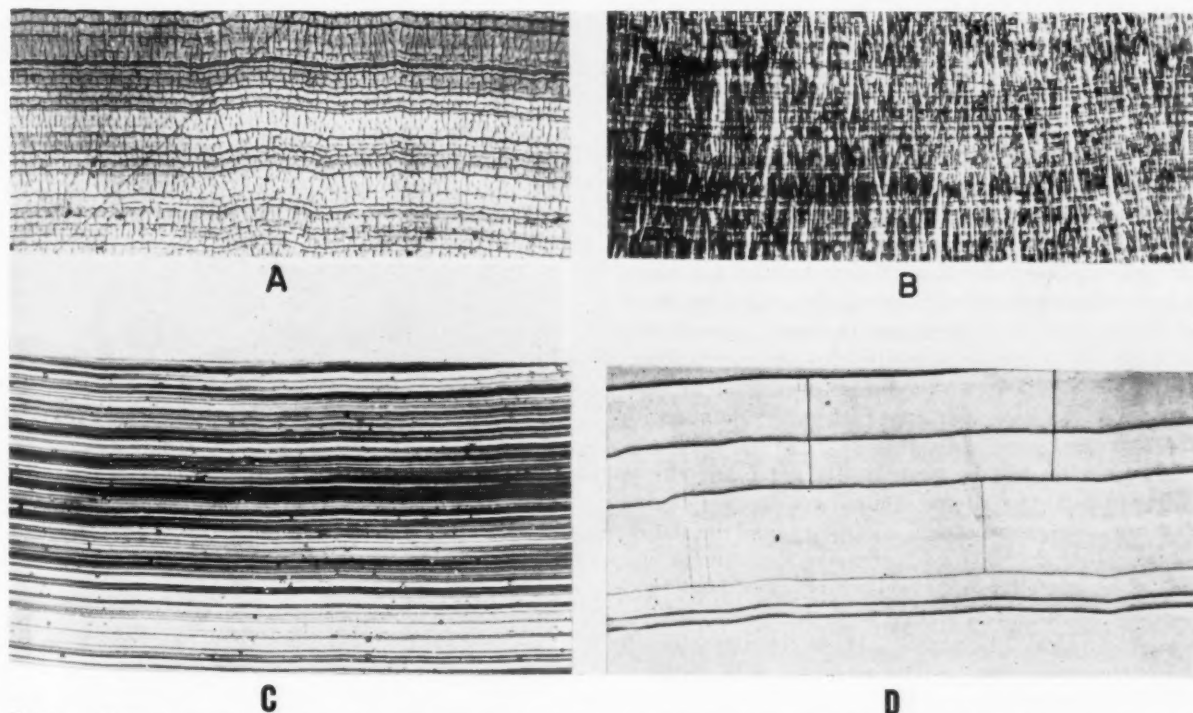


Figure 1. Photomicrographs of alloys of phosphorus with cobalt and nickel electrodeposited by means of a technique recently developed at the National Bureau of Standards. The low-phosphorus alloys show a columnar structure while the structure of the high-phosphorus alloys is laminated or banded. A, low-phosphorus nickel (2.3% phosphorus); B, low-phosphorus cobalt (2.2% phosphorus); C, high-phosphorus nickel (13% phosphorus); D, high-phosphorus cobalt (10% phosphorus).

# Navy Develops a Wear Testing Machine

By George W. Grupp, Washington, D. C.

THE testing of chromium plated cylinder liners in a Diesel engine is an expensive and slow procedure. This difficulty was overcome by the personnel of the Navy's Engineering Experiment Station Internal Combustion Engine Laboratory at Annapolis, Maryland, by their development of an accelerated wear test machine capable of testing simultaneously 24 different samples of chromium plating.

This machine will test the 24 specimens for the same cost of making one test with former methods. It also performs tests 20 times faster than the former methods, because 50 hours of testing with the new accelerated wear test machine is equivalent to 1000 hours with the older methods. What is more, the new Navy methods are more accurate than the older ones because with its present facilities it can measure actual wear of chromium plated surfaces to within 0.00001 of an inch.

Since 1939 the Navy, (the world's largest owner and operator of Diesel engines), has been using chromium plated cylinder liners in its Diesel engines to reduce cylinder wear, to prevent cylinder failures caused by corrosion or surface disintegration, and to reduce the wear of piston rings.

For some years the Navy has taken an active interest in finding ways and means to improve the wear resistance of chromium plated cylinder liners, and it is now engaged in an exhaustive study of the causes for wear resistance variations of different types of chromium plating. The objectives of this study program are to determine the physical characteristics of chromium plating (such as hardness, crystalline orientation, surface tensile stress), which will give the best wear resistance in Diesel engine cylinder liners.

The Navy sought out the services of *Dr. William Blum* and *Dr. Abner Brenner* of the National Bureau of Standards, who outlined for them a total of 3,861 different chromium plating possibilities with variations in the combination of such factors as bath temperature, current density, concentrations, and ratio of chromic acid and sulphate radical. In these tests the Navy hopes to learn the effect of various combinations of these factors on crystalline structure, hardness, internal tensile stress, etc. Each of these different plating combinations and metallurgical conditions will then be correlated with the wear resistance data as ascertained with the accelerated wear test machine.

These studies will be made by the combined efforts of certain personnel of the internal combustion engine laboratory, the metallurgical laboratory, and the statistical section of the Navy's Engineering Experiment Station. The metallurgical laboratory personnel will supervise the specimen plating procedure, and evaluate the metallurgical and physical characteristics of each type of chromium plating. The personnel of the internal combustion engine laboratory will supervise and record the actual wear test results. The statistical section will tabulate and analyze the statistical data and schedule the tests.

The tests made thus far with the machine seem to indicate that differences in cylinder liner wear rate is due to the quality of chromium plating rather than to differences in Diesel engine operation.

The cylinder liner wear test procedure may be divided into six steps, namely: (1) the preparation of the specimens; (2) the plating of the specimens; (3) the testing of the specimens in the wear testing machine; (4) the notation of wear test results; (5) the microscopic photographic and X-ray analyses of the tested specimens; and (6) the coordination and final analysis of all data on each specimen.

In the preparation of specimens, the first step is to machine the cylindrical steel sections so that they will fit properly in the wear-test machine after they have been plated. Then they are polished to remove all machine grinding marks. Next they are scrubbed with fine pumice powder, followed by a thorough rinse in water. To remove any grease, grit or light oxide film which may have formed on the sections during the period between the water rinse after scrubbing and their being attached to plating racks, they are dipped for a few seconds in a mild solvent solution, followed by a water rinse, and then immediately placed in the chromium plating solution. All variations in plating conditions and procedure are closely controlled.

After testing, chromium plated sections are cut into a sufficient number of test specimens to provide for adequate metallurgical, physical and X-ray investigations.

The accelerated wear test machine is strongly built and reliable in operation. The two sliders, which reciprocate in opposite directions, and the over-all rigidity of the machine aid in attaining minimum vibration. Each of the two sliders has a capacity of 12 chromium plated test pieces. Thus 24 different specimens can be tested simultaneously.

The machine maintains continuously assimilated high

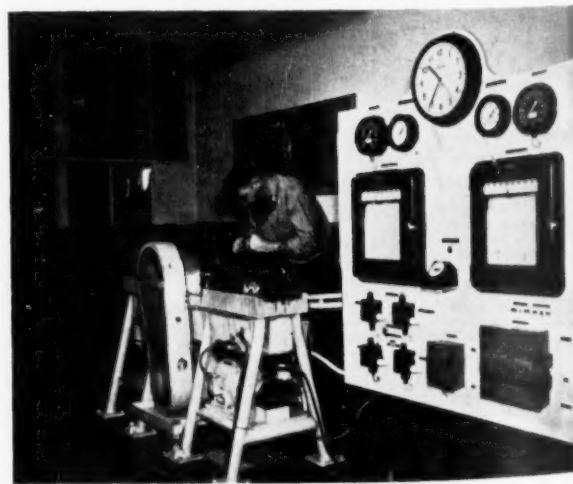


Fig. 1. Wear testing machine and instrument panel at the Navy Engineering Experiment Station.



Fig. 11. Closeup view of wear test machine.

pressures normally found in Diesel engine cylinders. Both the piston ring materials and the chromium plated specimens are subject to the same reciprocating contacts, the same rubbing velocities, and the same piston stroke reversals as experienced at the top of the piston stroke — the point of greatest wear.

The machine's power arrangement, with a 15 horsepower electric motor, insures a constant movement of the specimens at any desired speed. Usually, the machine is operated at a speed of 1,350 to 1,500 rpm.

As soon as the machine is set in motion a lubricating oil system sprays a fine film of artificially contaminated oil, (oil with controlled quantities of abrasives), to produce conditions as they prevail normally at the top of the Diesel engine cylinder.

Close to the bearing surface of each piston ring wear-piece a thermocouple is attached so that the operator of the test machine can note any changes in temperature, due to friction, on each of the 24 specimens.

When the specimens are removed from the testing machine the amount of chromium plate wear is then determined with delicate measuring devices.

With this accelerated wear testing machine the Navy hopes (1) to determine the most satisfactory plating thickness under different plating conditions, (2) to learn the wearing qualities of different plating thickness with various plating bath conditions and compositions, (3) to better understand the effect of notches on the life of chromium plated cylinder liners, (4) to ascertain what effect fatigue damage below the chromium plating has on the life of the plating, and (5) to determine how the wearing qualities of Diesel engine chromium plated cylinder liners are affected by cracks in the plating, by the presence of residual stresses in the chromium or steel, or both, as a result of plating, and by possible brittleness due to hydrogen.

The Navy believes that the tests on this machine will materially aid in the formulation of standard specifications of chromium plated cylinder liners, and that the studies will produce data which will aid in extending the life and dependability of Diesel engine chromium plated cylinder liners.

## ELECTROPLATING

(Concluded from page 65)

deposits are plated on a dull surface, they increase in brightness as they become thicker. As a result of the slightly dark cast of the high-phosphorus alloys, their reflectivity is 45 to 50 per cent, as compared with about 60 per cent for buffed nickel coatings.

When some of the phosphorus alloys are immersed momentarily in a solution of an oxidizing agent, such as ferric chloride, or made anodic in the plating bath, a jet black film is formed on the surface of the metal. This film is hard and adherent and appears to have possibilities for decorative use.

Photomicrographs of the low-phosphorus alloys show a columnar structure while the high-phosphorus alloys are found to have a laminated or banded structure. X-ray diffraction patterns of the high-phosphorus alloys show no crystalline structure. When heat-treated, the deposits develop a fine-grained structure instead of the large crystals characteristic of pure nickel or cobalt.

## Hardness

The hardness of the deposits as plated varies from 350 to 720 on the Vickers scale, increasing with phosphorus content. When the alloys are heat-treated at 400°C, they become much harder. For example, a heat-treated cobalt-phosphorus deposit containing about 10 per cent of phosphorus reaches a hardness of over 1100 Vickers, which is greater than that of electro-deposited chromium. Deposits which have been heated as high as 800°C and cooled are not appreciable softer than the initial deposit. However, the alloys have poor "hot hardness" and above a temperature of 600°C are softer than unalloyed nickel or cobalt.

Although the low-phosphorus alloys become ductile after heat treatment at 800°C, deposits containing more than 1 per cent of phosphorus are generally brittle. Alloys with higher percentages of phosphorus are highly resistant to corrosion and chemical attack, exceeding in this respect the pure metals. In experiments at the Bureau the nickel alloy with 10 to 14 per cent of phosphorus was attacked considerably less by hydrochloric acid than was pure nickel.

## Possible Applications

The pleasing appearance, ease of deposition, hardness, and corrosion resistance of the new alloys suggest the possibility of a number of commercial applications. Their use is indicated for gages, cylinder walls, piston rings, and other machine parts where resistance to wear is an important factor. In this connection, the more rapid rate of deposition as compared with chromium and the better throwing power of the plating bath should be of considerable advantage. Although the phosphorus alloys are not as white as bright nickel, the operation of the baths is much less critical than for proprietary bright nickel. The phosphorus alloys can be plated from a bath made up entirely of inorganic chemicals, whereas bright-nickel plating solutions must contain an organic brightening agent.

# Shop Problems

Abrasive Methods—Surface Treatments—Control  
Electroplating—Cleaning—Pickling—Testing

METAL FINISHING publishes, each month, a portion of the inquiries answered as a service to subscribers. If any reader disagrees with the answers or knows of better or more information on the problem discussed, the information will be gratefully received and the sender's name will be kept confidential, if desired.

## Patent Status of Aluminum Anodizing Procedures

**Question:** Can you give us any information regarding the present status of the patents covering the anodizing of aluminum and its alloys? It is our understanding that these patents are due to expire sometime soon.

R. A. W.

**Answer:** The original patent covering the chromic acid process was granted July 29, 1930 and has now expired. A number of patents were issued on the sulfuric acid baths in 1932 and 1933. The first, covering a bath of 60-77% sulfuric acid, was granted on July 26, 1932, and therefore would expire on July 26, 1949. Another patent, granted on the same date, covered baths of 15-35% strength. The patent which covers the most popular sulfuric acid bath of 10% strength was issued on March 7, 1933, therefore will expire on March 7, 1950.

A comprehensive article and digest of the patent situation on all types of anodizing baths was given in the December, 1945 issue of Metal Finishing by Mr. George B. Hogaboom.

## Ammonia Fumes from Brass Plating Tank

**Question:** We have noticed that lately we seem to be getting a strong odor of ammonia from our brass plating tank. As we have not had this problem before, and the bath has not been changed any, we are wondering if you can tell us where this is coming from. We do not add any ammonia to the bath.

P. L. H.

**Answer:** Ammonia comes from the decomposition of cyanide in the bath. You are either operating at too high

a temperature or at too high a current density. If it is necessary to operate this way, provision of a fume hood should be made to protect the operator from these fumes.

## Spray Metallized Coating of Baby Shoes

**Question:** Recently we heard of a process for metallizing baby shoes by using a sprayed tin-lead coating before copper plating. Can you give us any details on this method?

H. R. B.

**Answer:** Sprayed tin-lead coatings are applied with a special metal spraying pistol, using the lead-tin alloy in the form of wire or powder. These metallizing pistols can also be used for spraying a wide range of pure metals and alloys, and the wire can be purchased ready for use. The names of firms who can supply the pistols and wire are being forwarded. After spraying the tin-lead coating, this layer should be buffed smooth before the final copper plate is applied.

## Immersion Tinning of Stainless Steel

**Question:** Would the process of immersion tinning of aluminum given in the April issue of Metal Finishing work on stainless steel as well, or over chrome plate? If not, we would appreciate any formula that you could give us for doing this job, or for depositing copper or nickel on these surfaces.

B. A. H.

**Answer:** The method given in the above reference will not deposit tin on either stainless steel or over chrome plate. If the surface of the stainless steel is de-passivated, an immersion copper deposit can be made from an

acidified copper sulfate solution. Immersion nickel deposits can also be made on an activated stainless steel surface. The method is given in detail in Research Paper RP1835 of the Bureau of Standards. We have no information on the immersion deposition of either copper or nickel over chromium plate.

## Bright Dip for Stainless Steels

**Question:** Can you give us the formula for a good bright luster dip for use on stainless steel?

N. S. H.

**Answer:** Unfortunately there is no dip for stainless that will produce a lustrous surface in the same sense that aluminum is brightened. The usual acid baths produce a satin or frosty effect on stainless steel, and a number are given in the Guidebook-Directory. Electropolishing is very widely used to produce a lustrous surface on stainless steel of otherwise good surface quality.

## Testing Bright Nickel Plate

**Question:** We purchase bright nickel plated parts from several sources and frequently check plating thickness as the batches are received. We note that there is a wide discrepancy between the jet test method for checking thickness of deposit on equivalent thickness of plating received from different sources, and suspect that the discrepancy is due to the particular type of bright nickel plating done by our suppliers. Is there a way to determine what type of bright nickel has been applied to our parts before we check the thickness, so that we could use a correction factor?

V. A. R.

**Answer:** It is possible that a spot test could be worked out that would enable to differentiate between cobalt nickel bright plating and organic types of bright nickel, inasmuch as some cobalt is co-deposited with the nickel in a cobalt-nickel process. Such a spot test would have to be very specific for

cobalt in the presence of a large amount of nickel. Fiegl's book on Spot Tests should be consulted for possible reagents that might be used. At present there is no way of telling what particular organic bright nickel bath a given deposit has been made from. We suggest that a different method of testing be used in preference to the jet method. The magnetic method is less subject to error, and in addition is non-destructive. The microscopic method, while more time-consuming and destructive, is still the standard reference method for accuracy. Recent research indicates that considerable difference in corrosion resistance, especially in salt water atmospheres, may exist between the various types of commercial bright nickel deposits.

### Coloring Compounds

**Question:** Several of our polishers are in disagreement as to which is the best compound to use when coloring for high luster. Some prefer lime, others prefer red rouge, and still others green rouge. Can you tell us what is the usual commercial practice in this respect?

T. F.

**Answer:** Because so much is dependent on the operator, speed of the buff, and type of buff used, as well as several other factors, it is impossible to have any standardization for color buffing compounds. Generally speaking, white lime is used for color buffing copper base alloys and nickel plating. Red rouge is usually used only when the highest luster is desired on these metals. Green rouge is preferred for coloring stainless steel and chrome plating, although red rouge is also widely used for coloring chrome plate. Bear in mind that these are only generalities, and many operators will depart from these procedures and still produce high quality work.

### Duplex Finish on Casket Hardware

**Question:** We would appreciate your examining the sample piece of casket fitting which we are forwarding to your attention and letting us know how this duplex finish is created.

J. P.

**Answer:** The sample submitted was undoubtedly plated and then the high spots hand burnished, using a hardened and polished steel rod or ball. It would not be possible to produce

the high luster on the raised letters in the depressed areas in any other way, as a buff used for coloring these raised letters would also hit the surrounding areas. For best results, these same burnished areas should be burnished before plating with brass so that the final burnishing would be facilitated.

### Water Soluble Strippable Coating

**Question:** We have been using a strippable coating on our products to keep them from being scratched and marred during handling operations in the shop. However, the removal of this coating so the parts can be plated presents a problem, and we are wondering if there is such a strippable coating that could be washed off in water? If so we could easily remove it in our cleaning cycle.

H. G.

**Answer:** The names of firms that

can supply water-soluble strippable coatings are being sent to you. Another development along these lines is a new strippable coating that can be applied over finished lacquered parts without affecting the lacquer. Such a material is useful when finished parts must be stored before use.

### Copper Plating to Prevent Heat Treat Scale

**Question:** We have been copper plating steel parts with .005-.006" of soft copper to prevent scaling during the heat treating operation, and have run into trouble with the copper bubbling during the heat treatment.

H. J. F.

**Answer:** Your trouble comes from having too heavy a copper deposit on the parts. It should not be necessary to deposit more than .002" to prevent scaling and decarburization. In addition, the removal of the excess copper presents additional problems.

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# PATENTS

## Plating on Powdered Iron Articles

*U. S. Patent 2,491,839. R. B. Tinker, assignor to General Electric Co.*

The process for electroplating a sintered ferrous article containing a multitude of microscopic pores on its surface thereby to obtain a metallic coating free of a pitted, "sinking" effect, which process consists essentially of (1) surface-grinding the sintered ferrous article, (2) immersing the said sintered article in the absence of an electric current so as to impregnate it in a heated 0.5 to 30 per cent aqueous alkaline solution maintained at around its boiling point thereby to occlude small amounts of the alkaline solution within the pores of the sintered article, (3) removing the article and washing it with water, (4) immersing the washed article in and subjecting it to the action of an acid cleaning solution, (5) removing the article from the acid cleaning solution and electrolytically depositing a chromium coating on the surface of the cleaned article using an acid electroplating bath, (6) removing the electroplated article and rinsing it with water, (7) immersing the article again in the aforementioned alkaline solution to neutralize any acid remaining on the surface of the plated article, and (8) rinsing the article with water and drying it.

## Plastic Electroplating Barrel

*U. S. Patent 2,491,925. A. Lazaro.*

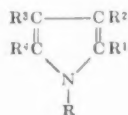
In a self-contained portable electroplating barrel unit, the combination of a supporting frame comprising longitudinal and transverse metal frame members secured together to provide a rectangular frame with the longitudinal frame members projecting longitudinally therefrom, a driving motor carried above and by said frame, a transverse drive shaft carried by said frame and connected by speed-reducing gearing to the shaft of said motor, said drive shaft carrying a driving gear constructed of chemically inert initially plastic material, a pair of depending bearing brackets carried by said frame and extending parallel to each other, an electroplating barrel consisting of a pair of thick end plates, said end plates being grooved on their

inner opposing sides and the said groove being of substantially the shape of a polygon, a single-sheet side wall for said barrel which is bent under the influence of heat at a plurality of obtuse angles, said angles being equally spaced from each other to form a regular polygon with the side edges of said body plate shaped to fit in said grooves, means for rotatably supporting said end plates on said depending bearing plates, said end plates, bearing plates and latter means being formed with an axial aperture at each end of the barrel, an insulated conductor secured to said depending plates and extending through said aperture at each end of the barrel and provided at its end with a metallic head which is socketed to receive the insulation of said conductor and counterbored to receive the conductor, a gear carried by one of said end plates and meshing the first-mentioned gear, said latter gears, depending plates and barrel all being made of said initially plastic chemically inert material and the ends of said barrel being integrally welded to the side edges of said body plate, a pair of hook shaped members of electrical conducting material carried by said depending plates and electrically connected to said insulated conductors for simultaneously supporting the unit on a bus-bar, and connecting the conductors and metallic members inside the barrel to one terminal of a source of direct current.

## Stabilization of Trichloroethylene and Tetrachloroethylene

*U. S. Patent 2,492,043. W. Klabunde, assignor to E. I. du Pont de Nemours & Co.*

A new composition of matter comprising a liquid chlorohydrocarbon selected from the group consisting of trichloroethylene and perchloroethylene which contains a stabilizing amount of a pyrrole having the formula:



where R represents a radical selected from the group consisting of hydrogen and alkyl and R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, and R<sup>4</sup> represent a radical selected from the group consisting of hydrogen, alkyl and halogen.

## Electrodeposition of Gold on Tantalum

*U. S. Patent 2,492,204. Russell D. Van Gilder, assignor to the United States of America as represented by the Secretary of War.*

The method of electrodepositing a strongly adherent gold film on tantalum grids of electronic tubes comprising heating said tantalum grid in a vacuum to a temperature of approximately 1900°C., allowing said tantalum grid to cool after it had reached said temperature, electrodepositing a gold film on said tantalum grid from an electroplating bath solution consisting essentially of gold chloride, sodium cyanide and water, rinsing the plated metal from said electroplating bath solution and heating said plated grid in a vacuum to a temperature of approximately 1100°C.

## Blast Cleaning Machine

*U. S. Patent 2,493,215. K. H. Barnes, assignor to American Wheelabrator & Equip. Corp.*

A centrifugal throwing wheel for projecting liquid comprising, a central portion; a hollow shaft supporting said central portion for rotation of the wheel about the shaft axis; a plurality of blades extending from said central portion to the outer periphery of the wheel; a central chamber within said central portion, said chamber having a radially directed elongated discharge opening in its peripheral wall adjacent to the inner ends of the blades adapted to discharge liquid there-through in substantially radial direction; and a pair of pressure ducts for supplying liquid under pressure into said chamber from both ends, one of said ducts extending through said hollow shaft, the chamber being liquid tightly closed except for said discharge opening, and the interior of the chamber being free from obstructions, whereby flow of liquid from said duct to said discharge opening is unimpaired.

## Dry Plate Selenium Rectifier

*U. S. Patent 2,493,241. S. S. Fry, assignor to Fansteel Metallurgical Corp.*

The method of producing blocking layer devices which comprises providing a supporting electrode with a layer of gray, crystalline selenium, subjecting the surface of the selenium layer to the action of hot cyanogen gas and

applying a counter-electrode over the treated selenium surface.

### **Aqueous Composition for Phosphating Iron and Steel**

*U. S. Patent 2,493,327. D. W. Vance, assignor to Kelite Products, Inc.*

A composition for treating iron and steel which composition consists of an aqueous solution including phosphoric acid 7.4 to 18.4%; formic acid 0.6 to 1.5%; zinc 0.025 to 0.06%; ethylene glycol monobutyl ether 0.9 to 2.4%; wetting agent 0.05% to 0.12%, and the remainder 91.0 to 77.5% water.

### **Recovery of Silver from Solutions of Silver Salts**

*U. S. Patent 2,493,396. E. Farber, and M. Sciascia, assignors to Timber Engineering Co.*

A process for recovering silver from a dilute solution of a silver compound, which comprises contacting said solution with a solid insoluble lignin, separating the solution therefrom and recovering the silver from the lignin, said lignin having been activated by the removal of minerals therefrom by washing with a dilute mineral acid and the removal of organic non-ligneous materials therefrom, by washing with an alkali, said acid and said alkali being non-reactive with said lignin.

### **Anodic Polishing of Steel and Iron**

*U. S. Patent 2,493,579. M. B. Hammond, and G. B. Bowman, assignors to Standard Steel Spring Co.*

A solution for use in the electrolytic polishing of steel and iron articles wherein the article is employed as an anode, said solution consisting essentially of and containing by weight 55 to 85% phosphoric acid, 7 to 30% water, 1 to 15% of a member of the class consisting of tri-alkali metal phosphate, di-alkali metal phosphate, mono-alkali metal phosphate, and phosphorus pentoxide, and at least 0.5% of a sulphate of the class consisting of alkali metal sulphate and ammonium sulphate.

### **Selenium Metal Rectifier**

*U. S. Patent 2,493,643. E. A. Richards, assignor to International Standard Electric Corp.*

A metal rectifier comprising a metal base, an insulating layer covering a

portion of said base, a semi-conductor layer on said base and a counter-electrode layer on said semi-conductor layer, both said semi-conductor layer and said counter-electrode layer overlying said insulating layer.

### **Buff**

*U. S. Patent 2,493,791. L. J. Walling, assignor to Charles R. Stoddard and Robert Harding, Jr.*

A buff comprising a plurality of cables, each of said cables comprising a plurality of strands and a flexible casing surrounding said strands, and means to attach each of said cables to the cables adjacent to it.

### **Protective Coatings on Aluminum Alloys**

*U. S. Patent 2,493,934. C. L. Waring, assignor to Reynolds Metals Co.*

A process for treating alloys predominantly aluminum rendering said articles substantially resistant to corrosion comprising the steps of subjecting the article to an aqueous bath consisting of sodium carbonate, 5 to 10 per cent; sodium hydroxide, 0.1 to 0.4 per cent; potassium dichromate, 0.2 to 2.0 per cent; aluminum chloride, 0.1 to 0.3 per cent; said bath being maintained at a temperature of from 180 to 212°F., for a period of from 5 to 20 minutes, washing the so-treated article, subsequently subjecting the article to a second bath, consisting of from .012 to 0.1 per cent of chromic acid in aqueous solution at temperatures ranging from 135 to 145°F., for a period of from 5 to 10 minutes.

### **Direct Nickel Plating on Die Castings**

*U. S. Patent 2,494,205. R. H. Rogge, and E. J. Roehl, assignors to The International Nickel Co., Inc.*

A process for electrodepositing nickel directly on zinc-base metal compositions which comprises establishing a bath having a temperature of about 100°F. and a pH within the range of about 5.3 to about 6.2, and containing tartrate ions in an amount equivalent to a tartaric acid concentration of about 30 to about 60 grams per liter, nickel ions and chloride ions in amounts equivalent to a nickel chloride concentration of about 20 to about 40 grams per liter, ammonium ions equivalent to the amount of ammonium hydroxide required to regulate

the pH of said bath within said range, and the balance of the bath being essentially water, said bath being substantially devoid of sulfate ion, and electrodepositing nickel from said bath at a current density of about 10 to about 90 amperes per square foot upon a zinc-base metal composition, whereby a thick, ductile and adherent nickel plating substantially free from streaks is obtained.

### **Continuously Purifying and Concentrating Acid Pickling Liquors**

*U. S. Patent 2,492,333. N. Swindin.*

Apparatus for the continuous purification and concentration of spent hot sulphuric acid iron pickling liquors with the removal of copper as therefrom and the addition of the required fresh sulphuric acid thereto, comprising a plurality of open topped tubes, means for feeding spent pickling liquor to said tubes, a sealed settling tank to which said tubes are connected at their bases, a vertical barometric column extending upwardly from the settling tank, a vacuum pump connected to the head of the barometric column and operative to draw liquor from said tank up said column and to overflow the top thereof, external jackets enclosing said open topped tubes and said barometric column and having means interconnecting their lower ends externally of said tank, passages being provided between said jackets and said open topped tubes and barometric column for the flow of liquors overflowing the barometric column in a direction counter to the direction of flow of the liquors in the open topped tubes and barometric column.

### **Pyrophosphate Copper Plating Bath**

*U. S. Patent 2,493,092. J. E. Stareck, assignor to United Chromium, Inc.*

A method of depositing dense and adherent copper, consisting in passing electric current from an anode to a cathode-object immersed in an aqueous bath having a pH between 7.5 and 9.5, and a temperature between 70°F. and 160°F., and in which the bath consists essentially of 7.5 to 45 g. l. bivalent copper, 100 to 250 g. l. pyrophosphate ( $P_2O_7$ ), 5 to 20 g. l. nitrate ( $NO_3$ ) and 1 to 3 g. l. ammonia ( $NH_3$ ).

# Recent Developments

New Methods, Materials and Equipment  
for the Metal Finishing Industries

## Removing Water from Metal Articles

*Chemclean Products Corp., Dept. MF, 64 Sixth Ave., N. Y. 13, N. Y.*

Drying finished metal products has always been a problem to the manufacturer and plater. The old stand-by, sawdust, often contaminates the work, especially in recessed sections. Warm air drying often results in staining, and even hot water may leave residual salts after evaporation, showing as stains or white spots.

For that reason, a water-remover called Aqua-Off has been developed by the above firm to remove water from plated or unplated work, such as pieces that have been polished, cleaned in alkali cleaner and then rinsed in hot or cold water prior to storing or lacquering. For a dry surface, free of water stains, the work is immersed in the Aqua-Off after the final hot water rinse, gently agitated, and then removed. Water is displaced and falls to the bottom of container, leaving the work free from water but covered with a slight film from the Aqua-Off, which is readily removable by holding it in the vapors in a degreaser.

This procedure eliminates the use of sawdust or drying cabinets with their attendant disadvantages, it is claimed.

## Tripoli Compositions

*The L. H. Butcher Co., Dept. MF, 2628 E. Olympic Blvd., Los Angeles, Calif.*

This firm announces the development of three new tripoli compositions, specially compounded for specific operations, and available in all sizes for hand or automatic buffing.

T-70—for buffing brass and copper articles. This compound is a medium hard tripoli bar which will not break in contact with the buffing wheel. Said to be excellent for wheel economy and ease of cleaning prior to plating.

T-30—for obtaining exceptionally

high color on copper or brass. A double duty compound used for cutting and coloring, similar to T-70 in wheel economy and fast cleaning.

T-90—for brass, copper and die castings. This compound is claimed to be exceptionally fast cutting product and readily removed in cleaners and degreasing solvents. Removes die marks, burrs, scratches and other imperfections.

## Portable 24v. D.C. Power Supply

*Richardson-Allen Corp., Dept. MF, 15 W. 20th St., N. Y. C.*



This firm, specialists in rectification, has developed a compact, portable, closely regulated power supply for use in testing laboratories, on production lines, for testing radio communication and electrical equipment in airplanes, etc.

This handy unit has a selenium rectifier, full wave, six phase, A.C. Input: 220 volts, three phase, 60 cycles; delivers D.C. 24 to 32 volts, 30 amperes. The supply is continuously variable from 24 to 32 volts by rheostat control saturable reactor. Regulation: plus or minus 4% from 0 to full load, D.C. ripple: 1.5%. Ambient temperature: operates at 40°C.

Convection cooled—speed of response, 0.4 second.

Voltmeter, ammeter, 6 ft. of three phase cord with locking plug, D.C. circuit breaker, A.C. fuses, on/off switch and pilot light are included in the outfit, which is housed in an aluminum cabinet 18" high, 14" deep and 15" wide with handles for carrying. Weight, 150 pounds. Further technical information will be furnished promptly by the manufacturer.

## Metal Degreaser

*Barco Chemical Products Co., Dept. MF, 701 S. LaSalle St., Chicago 5, Ill.*

Barco Metal Degreaser quickly and thoroughly removes all oil, grease, waxes, etc., it is claimed.

No heat is necessary. Metals or plastics are degreased either by immersion of parts in the fluid, by dipping and brushing (where grease is extra heavy), or by wiping with the fluid. Parts with painted surfaces (with very few exceptions) can be degreased without harm to the painted surface, it is claimed.

There is no distortion of parts due to expansion and contraction from changes of temperature, as is sometimes the case in using hot solvents or vapors. Write for literature and information.

## Blast Cleaning with Wet Abrasives

*The Cro-Plate Co., Dept. MF, Hartford 5, Conn.*

This firm announces their new wet blasting machine for cleaning parts prior to plating, etc. Named "Cro-Hone," the equipment is constructed of corrosion resistant metals throughout. No circulating pumps are required for circulating the wet abrasive mixture; this is done with siphon jet guns and air agitators. The machine fits into a 30 x 30" space, and is about 5 ft. high. Removable drawer-type fil-

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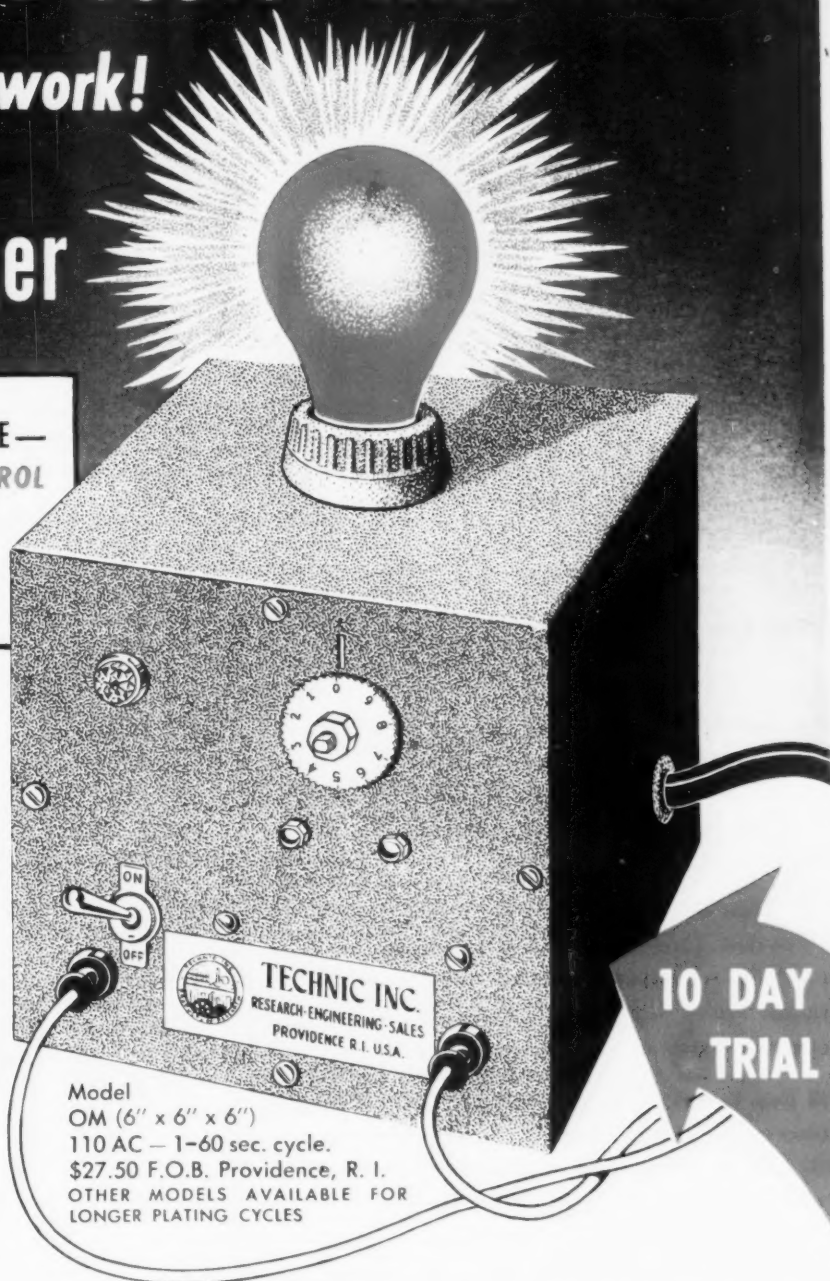
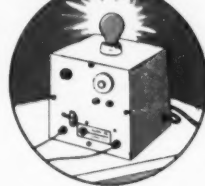
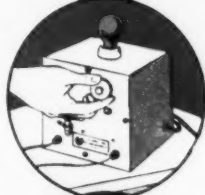
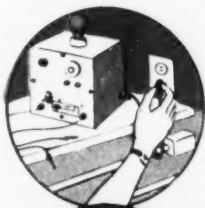
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IN LESS THAN A MINUTE!

Plug into electrical  
outlet. Clamp lead  
wires to tank rheo-  
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Set dial for de-  
sired plating time.  
No need to reset  
unless cycle  
change is re-  
quired.

Insertion of work  
in the tank auto-  
matically starts  
timing cycle.

Red light signals  
completion of  
cycle — AND re-  
moval of work  
automatically  
resets the timer to  
the same cycle —  
ready for the next  
batch.



Model  
OM (6" x 6" x 6")  
110 AC — 1-60 sec. cycle.  
\$27.50 F.O.B. Providence, R. I.  
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LONGER PLATING CYCLES

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The new TECHNI-TIMER takes the guesswork — and the work — out of short cycle timing. It cuts plating costs by preventing overplating . . . cuts operating time and speeds batch output by eliminating manual resetting. Its automatic action does not interfere with or cut off plating current.

ORDER NOW! Use the TECHNI-TIMER for 10 days. If not completely satisfied that the TECHNI-TIMER will out-perform ordinary timers — and save you money — return to Technic Inc. and your money will be promptly refunded.



## TECHNIC INC.

39 SNOW STREET, PROVIDENCE, R. I.

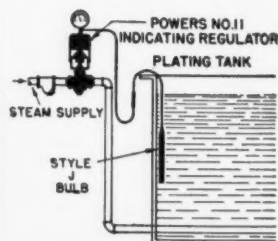
SUPPLIERS OF A FULL LINE OF RECTIFIERS, PERIODIC REVERSE UNITS, ETC.

METAL FINISHING, July, 1950



# POWERS

## TEMPERATURE CONTROL



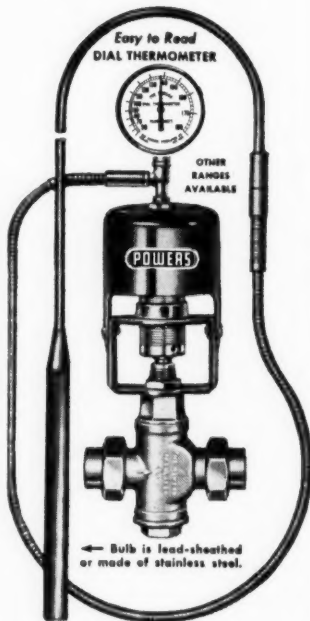
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**Will Help You Get a Better Product at Lower Cost** Better temperature control of plating solutions will help reduce rough plating, buffing time, insure plating within the bright range and reduce decomposition of solutions. Powers regulators pay back their cost many times a year. They are—

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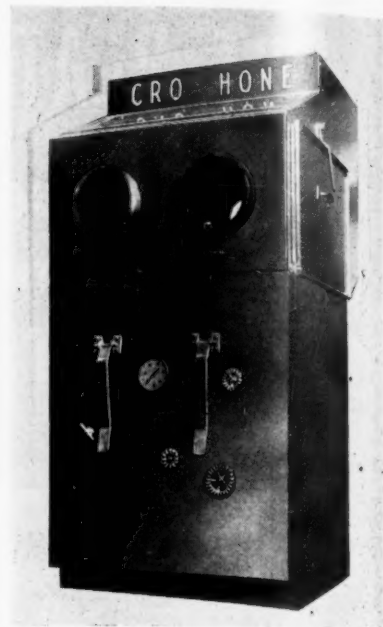
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ters are used. The entire unit is said to be engineered for economical and trouble-free wet abrasive blasting of a wide range of parts. The accuracy of stock removal with finest abrasives (up to 5,000 mesh), and the uniformity of the surface finish produced are said to make this machine one of the most versatile pieces of surfacing equipment now available. For further details write to the manufacturer at the above address.

### Electrocleaner

*The DuBois Co., Dept. MF, Cincinnati 3, O.*

This firm recently announced its new electrolytic cleaner, Alkon.

Alkon is suitable for either direct or reverse current cleaning of both ferrous and cuprous metals, it is claimed, and combines the attributes of a hot-tank cleaner, wetting, emulsification, soil suspension, hard water control, with the necessary electrical properties. Other features claimed are: foam control to eliminate solution splattering and minor explosions, relatively low using concentrations, and long solution life. Further details may be obtained by writing to the above address.

### Immersion Radiant Heating for Plating Baths

*Pyrosil, Inc., Dept. MF, 1889 Front St., Cuyahoga Falls, O.*

Claimed by the above firm to be completely inert to chromic acid, nitric acid, hydrochloric acid, and sulfuric

acid of any concentration and temperature, the Pyrosil Hot Rod heating elements are said to be ideal for heating plating and pickling baths where rapid heating, no heat loss, and close temperature control are essential. They are available in sizes from 1,000 watts to 10,500 watts. Immersion depths from 6-38", O.D. from 1 7/8"-2 3/8". Complete information and prices on request to the above address.

#### New Method of Test for Total Water Hardness

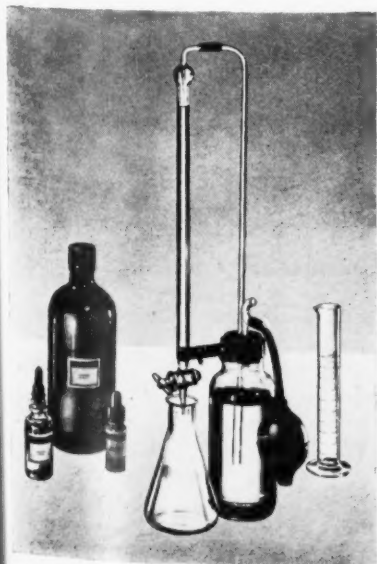
Eberbach & Son Co., Dept. MF,  
Ann Arbor, Mich.

The slow and tedious Soap Test for determinations of total hardness of water is out of date, according to this firm.

As the result of research begun at the University of Zurich and followed by a study of the method at Iowa State College a simple and accurate test has been developed which not only cuts the time per test, but also minimizes the possibility of errors.

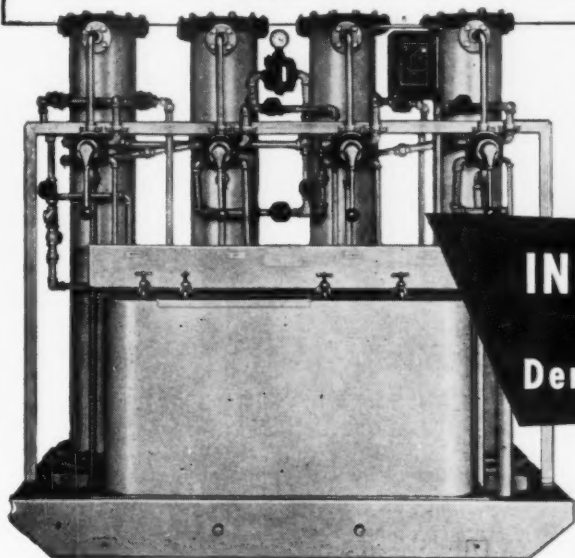
The technique is simple—to a 50 ml. water sample add 5 drops of indicator and 0.5 ml. of buffer reagent and mix. Into this, by means of the automatic burette, add hardness reagent and mix. When the exact end point is reached, the solution changes instantly from red to pure blue. The volume of hardness reagent used (in ml.) is multiplied by 20 to give the total hardness in ppm. Better than 70 tests can be made with the original set if the hardness does not exceed 100 ppm. Replacements are available for this set.

The complete set includes automatic



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a thousand gallons  
with . . . .

## INDUSTRIAL Water Demineralizers

A four-bed Industrial Water Demineralizer. Standard two- and four-bed units available with capacities of 200 to 1000 gph. Special units of any capacity—engineered to requirements.

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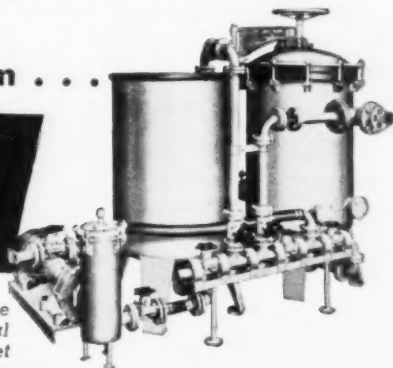
besides the extremely low cost, there is nothing complicated about getting the chemically pure water with Industrial Demineralizers. Raw water is passed through either two or four beds of ion-exchange resins and it comes out free of the dissolved mineral salts. No still, heat, steam, or cooling water is needed—keeping space requirements relatively small.

And it's simple to get the complete facts for your case. Send us a water analysis and let us know how much water you have to treat and the gallons per hour needed. We can then give you the whole demineralizer story including estimated costs, equipment required, performance data, etc. for your requirements.

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*Start* clean ... *stay* clean with Red Label Darco S-51! Darco adsorbs impurities to its surfaces before they can be deposited on the freshly cleaned surface of your work.

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burette, graduated cylinder, flask, hardness indicator, hardness buffer, hardness reagent and complete instructions.

### Germicidal Cleaning of Goggles and Masks

*American Optical Co., Dept. MF, Southbridge, Mass.*

A new cleaning solution for personal safety equipment such as goggles, respirators and helmets is announced by the above firm.

Combining the best properties of both a germicide and detergent, the No. 101 Germicidal Detergent removes dirt and deposited skin oils without inducing corrosion, staining or deterioration of rubber, plastic, or metal parts, it is claimed. The solution may

be used as a spray, swabbing or immersion solution.

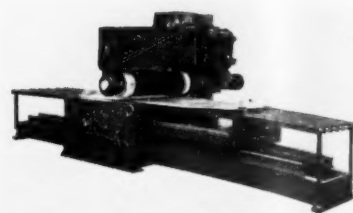
Tests also prove the new product, the company said, to be neither a primary nor a secondary irritant, even after repeated usage.

Available in gallon containers or 2 oz. bottles packed 10 to a carton. A gallon of the solution makes 64 gallons of cleanser.

### Oscillating Roll-Type Sheet Buffing Machine

*The Hill Acme Co., Dept. MF, Cleveland, Ohio.*

This firm announces a new 48" wide "Hill" openside oscillating-type sheet buffing machine, with hydraulic table and power elevating and lowering head



for 18" diameter buff roll or Tampico brush roll.

The Hill buffing machine is recommended for heavy-duty production finishing of ferrous and non-ferrous sheets.

The oscillating mechanism is powered by a 3 H.P. motor and has a stroke variation from 1/2" to 2", and a range of 50 to 150 cycles per minute.

The main spindle is powered by a 50 H.P. to 100 H.P. main drive motor. The machine is built in table widths up to 72" and table lengths of 8 ft. and over.

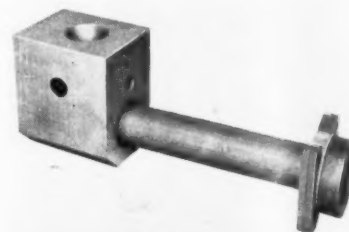
### Karbate Circulating Steam Jets

*National Carbon Div. Union Carbide and Carbon Corp., Dept. MF, 30 East 42nd St., New York 17, N. Y.*

The Series FM-1A Karbate impervious graphite circulating steam jet is announced by the above firm.

The jet itself is made entirely of Karbate impervious graphite, while the riser is a standard Karbate impervious graphite pipe fitted with a Neoprene gasket at the submerged connection to the jet and a Type V flange connection at the other end, permitting simple connection to steam lines. This construction assures complete resistance to the corrosive action of the liquid being heated, it is claimed. They are available in two sizes, Size 2 and Size 4, with riser assemblies up to 9' - 3 3/4" in height, and supplement the two types of Karbate impervious graphite heat exchangers which are used for indirect heating of open tanks.

These circulating steam jets are particularly adapted to the heating of liquids in tanks where agitation, good circulation and low cost are requisites



and when dilution of the solution is not harmful. They are claimed to withstand the action of practically all corrosive liquids, including sulphuric acid, hydrochloric acid, and nitric-hydrofluoric acid mixtures, and are recommended for heating acid solutions, for dissolution of lump or powder chemicals, for circulating acid solutions in ore digesters, for cooking, and for many other operations performed by injection of steam. They can be subjected to severe thermal shock without cracking, chipping or spalling, according to the firm.

A copy of Catalog Section M-9101 which completely describes the steam jet and gives design, installation and operation details, may be obtained by writing.

#### Industrial Rubber Gloves

The B. F. Goodrich Co., Dept. MF, Akron, O.



A new industrial rubber glove, called "Gripriite" is announced by this firm. Made with a roughened surface which is an integral part of the glove, it insures a firm, tight grip even in the wettest application, allowing work under these conditions to be accomplished with ease and speed. The glove enables the wearer to grip the smallest objects firmly and with confidence, it is claimed.

Made by the celebrated Anode process, the glove has curved fingers, is 14 inches long, identified by an orange band at the cuff, and made in sizes 9, 10 and 11 in black.

Advantages of the glove, the manufacturer says, are its high tensile, uniform strength, excellent snag and tear resistance, highly flexible, strong fing-

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- Greaseless Composition
- Emery Cake
- Brass Coloring
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er crotch and with long life and aging qualities.

#### Automatic Moisture Eliminator from Compressed Air

Master Equip. Co., Dept. MF, P.O. Box 55, Dayton 1 O.

A pet cock with a "brain" which is claimed to automatically eject moisture and oil from air line traps and air compressors is announced by the above firm. The new product is precision built, compact, efficient and easy to install, it is claimed. It is two inches high, weighs only three and one-half ounces.

According to the manufacturer, it operates on the build-up and relief of pressure, automatically ejecting all water and oil twice for each operation of the equipment. It is made in two

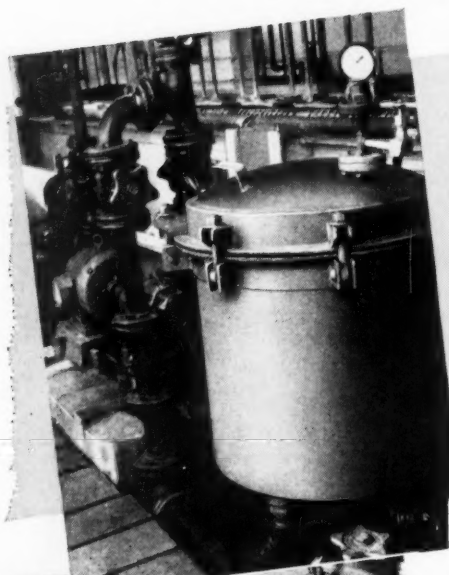
different models: one especially designed for automotive air brake systems, the other for industrial applications.

#### Measuring Concentration of Trichlorethylene Vapors

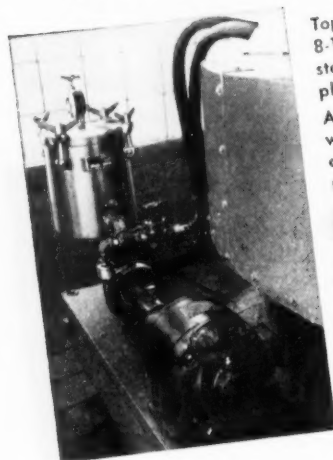
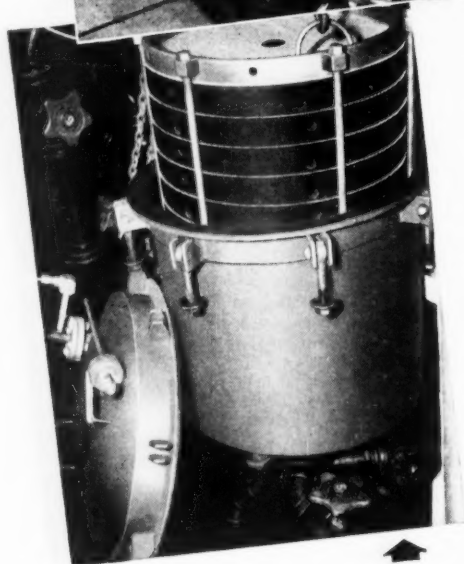
Davis Emergency Equip. Co., Dept. MF, 45 Halleck St., Newark, N. J.

The above firm is now making available to industry a new instrument for the toxic range analysis of halogen derivatives of hydrocarbons, to be known as the Davis Halide Meter. This new analyzer, originally perfected by E. I. duPont de Nemours & Co., employs a photo-electric photometer to indicate changes in the intensity of the blue spectrum of a copper arc discharge in the presence of organic

**No repairs or maintenance  
in over 17,000 hours of  
'round-the-clock operation**



**... yet this  
SPARKLER  
Horizontal Plate  
FILTER  
is still going strong**



Top: Sparkler Model 8-18 filter shown installed in Gillette's plating department.

Above: Same filter, with filter plate assembly being removed for cleaning

Left: Sparkler Model 8-6 stainless steel filter. This portable unit is used by Gillette to filter gold plating solutions.

The kind of service Sparkler Horizontal Plate Filters have given the Gillette Safety Razor Company—efficient and trouble-free, even under most extreme conditions—is the kind of service that is vital to *every* filtering operation.

For example: A rubber-lined Sparkler Model 8-18 filter is used by Gillette in the continuous filtration of a 1000-gallon bright nickel plating solution. Now operating for approximately two years, this filter has been on a 24 hours a day, 7 days a week schedule — without any loss of operating time for repairs or maintenance. Also used in periodic batch carbon treatments of nickel solutions this unit, according to Gillette technicians, consistently delivers a brilliantly clear effluent, even though the plates may be packed solid.

Another Sparkler Filter employed by Gillette is a Model 8-6, stainless steel, portable unit. Used exclusively for cyanide type plating solutions, this Model 8-6 has proved particularly valuable for Gillette's gold plating operations since the patented Sparkler Scavenger Plate assures minimum loss of precious gold solution. Now operating almost six months for at least 2 hours daily, its performance has been satisfactory in every respect.

*Our Engineering Department (with more than 25 years' experience in every phase of filtration) is available for consultation without charge.*

**SPARKLER MANUFACTURING CO.**

MUNDELEIN, ILLINOIS

halide vapors. The readings of the meter are claimed to be accurate to within 10%, and the sensitivity for Halide derivatives increases approximately as the number of halogen atoms per molecule.

The instrument is compact (dimensions approximately 15" x 16" x 9¾") and portable (weight 35 pounds) and operates on 110 volt, 60 cycle current. The manufacturer claims that this analyzer is particularly adaptable for detecting leaks of methyl chloride, dichlorodifluoromethane, methylene chloride, carbon tetrachloride, trichlorethylene, perchlorethylene and methyl bromide, etc.

#### Di-Phase Metal Cleaners

Glyco Products Co., Inc., Dept. MF, 26 Court St., Brooklyn 2, N. Y.

A new, simple method for making and using di-phase metal cleaners with very good detergency is based on having a system in which the water and solvent remain as separate layers.

The solvent consists of a chlorinated solvent such as trichlorethylene to which is added mineral spirits to give a final specific gravity greater than the water layer, which remains on top of the solvent. Phosphates are frequently added to the water to help clean water-soluble dirt from the metals.

The efficiency of this system depends on the addition of Polyethylene Glycol 400 (Di-Tri) Ricinoleate S-556U, about ½%, to the solvent. S-556U acts as an organic solvent wetting agent for the metals, helping remove grease and oils from the metals rapidly, it is claimed. Not only does it act as a preferential wetting agent in the solvent for metals, but also as an emulsifying agent when the metal parts are raised through the water layer, causing more effective removal of trace greases and other adhering dirt, according to the firm.

Cleaning by this di-phase system is done simply by dipping the metal parts through the water layer into the solvent and then within a short time bringing them up through the water layer, with a minimum of agitation or other mechanical cleaning methods. This system is not heated, thus avoiding difficulties with toxic fumes, fire hazard, loss of solvent and change in composition of the two phases.

Samples of Polyethylene Glycol 400 (Di Tri) Ricinoleate S-556U are available from the manufacturer.

## Bench Tumbling Barrel

Daniels Plating Barrel & Supply Company, Dept. MF, 129 Oliver Street, Newark 5, N. J.



The above firm announces the development of the above pictured Bench Tumbling Barrel which is designed for handling odd lots in finishing shops that are often set aside for larger jobs or for want of the right equipment.

This machine may be operated as an oblique barrel or as a horizontal barrel, thus handling a great percentage of all types of work. The barrel may be used wet or dry; and also has great value as a sawdust drying machine. Cylinders are fabricated from hard maple, steel or neoprene-lined steel etc.

It is ideal for laboratory or experimental work.

The operation has been simplified by a belt drive from a ratio motor.

The cylinder is motivated by friction rollers especially designed to be free of slippage and nearly noiseless in operation.

The adjustable angle brake holds the cylinder securely in the various positions as indicated above with a freely working release clutch for changing position.

## Vapor-Spray Degreaser

Circo Products Co., Dept. MF, 6531 Euclid Ave., Cleveland 3, O.

The design of a new, large capacity vapor-spray degreaser has just been announced by this company. This new model, called the C-120, was designed for heavy industrial use. It has a vapor depth of 34", inside length of 96" and width of 60".

The C-120 Circo degreaser is available in either nickel clad, stainless clad or zinc sprayed construction. Its

## CASE HISTORIES

### 5 Hours Saved Per Batch Descaling, Deburring and Burnishing Rifle Parts.

**Parts to be cleaned:** Triggers, sights, extractors and other small rifle parts. These are stamped parts with sharp burred edges; some have scale deposits from heat treating.

**Former Method:** Parts placed in barrel and burnished for 6 hours, using steel balls.

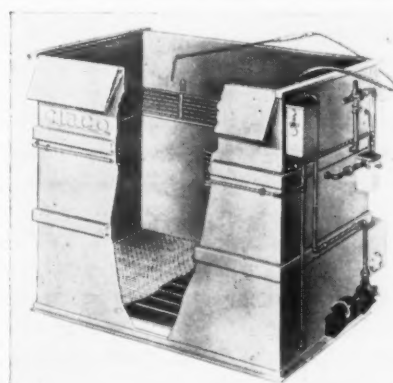


**Present Method:** 1. Scaled parts are rotated in barrel for 25 minutes with alundum chips, Magnus D-Scale-R and water to wet chips and work. 2. At end of 25 minutes, drain and flush barrel. 3. One pound of Magnus Alka-

line Cleaner is then added, and barrel is rotated 5 minutes to neutralize Magnus D-Scale-R, then drained. 4. Water is added to cover work, together with one pound of Magnus No. 59, and the barrel rotated for 25 minutes. 5. Barrel is then drained and flushed. Those parts not heat treated and scaled go through 4 and 5 only.

**Advantages:** Finishing time and costs are greatly reduced, as total time is now only 1 hour on scaled parts, and 1½ hour on unscaled parts. Former time was 6 hours. Scale is completely removed, deburring is perfect, and parts have a much higher luster than by former method.

Magnus's 29 years of solving cleaning and finishing problems assure you of business-like recommendations. If barrel descaling and deburring won't work on your parts, — we'll say so. If we say it will save you time and money — you can know it's a sound recommendation. For information write Magnus Chemical Co., 11 South Avenue, Garwood, N. J. In Canada — Magnus Chemicals Limited, 4040 Rue Masson, Montreal 36, Que. Service representatives in principal U.S. cities.



nonflammable, non-explosive solvent is heated by steam, gas or electricity, forming a blanket of vapor which is 34" deep. Ample heat input assures a cleaning capacity of 18,000 lbs. per hour, it is claimed. An outside water jacket and inside water coils give double protection against vapor loss.

Safe, economical operation is assured by a fully automatic control system.

## Line-Operated pH Meter

Coleman Instruments, Inc., Dept. MF, 318 Madison St., Maywood, Ill.

This firm announces its new Model 30 AC line-operated pH Meter. Designed for operation at 95-130 volts, 50/60 cycles, this new instrument is characterized by its high stability and almost complete freedom from drift, according to the manufacturer. Accuracy and reproducibility to within 0.05 pH. Continuous, direct reading in pH or Millivolts. Polarizing current available for Karl Fischer Titrations.

The instrument is enclosed in a black stain-and-corrosion-proof plastic enclosure equipped with a storage well for protection of the electrodes.

## Sizing and Grading Polishing Grits

The following table gives the allowable grain size limits of aluminum oxide and silicon carbide abrasive grains for polishing uses. This table has been designated as *Simplified Practice Recommendation R118-50*, Abrasive Grain Sizes by the *Commodity Standards Div.* of the *National Bureau of Standards*.

Grit No.	Sieve through which 100% must pass	Control Sieve		Maximum of oversize on control sieve	Minimum through control sieve and retained		Cumulative minimum through control sieve and retained		Maximum of 3% through sieve No.
		No.	Opening		Per cent	On sieve No.	Per cent	On sieve No.	
			Inches	Per cent					
8	6	7	0.111	15	45	8	80	8 & 10	12
10	7	8	.0937	15	45	10	80	10 & 12	14
12	8	10	.0787	15	45	12	80	12 & 14	16
14	10	12	.0661	15	45	14	80	14 & 16	18
16	12	14	.0555	15	45	16	80	16 & 18	20
20	14	16	.0469	15	45	18	80	18 & 20	25
24	16	20	.0331	20	45	25	75	25 & 30	35
30	18	25	.0280	20	45	30	75	30 & 35	40
36	20	30	.0232	20	45	35	75	35 & 40	45
46	30	40	.0165	30	45	45	65	45 & 50	60
54	35	45	.0138	20	45	50	75	50 & 60	70
60	40	50	.0117	30	45	60	65	60 & 70	80
70	45	60	.0098	15	45	70	70	70 & 80	100
80	50	70	.0083	15	40	80	70	80 & 100	120
90	60	80	.0070	15	40	100	70	100 & 120	140
100	70	100	.0059	15	40	120	65	120 & 140	200
120	80	120	.0049	15	30	140	60	140 & 170	230
150	100	140	.0041	15	40	170 & 200	75	170, 200, & 230	270
180	120	170	.0035	15	40	200 & 230	65	200, 230, & 270	
220	140	200	.0029	15	40	230 & 270	60	230, 270, & 325	
240	170	200	.0029	5	8	230 & 270	38	230, 270, & 325	

NOTE 1.—These specifications shall not apply to abrasives used in the manufacture of abrasive paper and cloth products (coated abrasives).

NOTE 2.—The sieves referred to above are those of the United States Standard Fine Sieve Series certified by the National Bureau of Standards, or equivalent.

NOTE 3.—The allowable limits set forth in the above table are based on the shaking of a 100-gram sample for 5 minutes on a Rotap machine operated at a speed of 290 rpm and 156 taps per minute. Where more than a single sieve is used they are to be agitated simultaneously.

NOTE: The following is an example of the use of the preceding recommendation: Taking grit No. 10, all material must pass through the coarsest sieve—in this case the No. 7. Through the next to the coarsest sieve, termed the "control sieve" (in this case the No. 8) all material may pass, but not more than 15 per cent may be retained on it. At least 45 per cent must pass through No. 8, the control sieve, and be retained on No. 10 sieve, but it is permissible to have 100 per cent pass through No. 8, the control sieve, and remain on No. 10 sieve, the requirement being that the grain passing through No. 8, the control sieve, and retained on No. 10 and No. 12 must add to at least 80 per cent. Consequently, if 45 per cent passed through No. 8 sieve, the control, and was retained on No. 10 sieve, then at least 35 per cent must be retained on the No. 12 sieve. There is no requirement for material retained on the finest sieve—in this case the No. 14 sieve—but not more than 3 per cent is permitted to pass through the No. 14 sieve.

## Business Items

### United Chromium Adds Research Engineer



Donald D. Clark

Donald D. Clark has just been added to the research staff of *United Chromium, Inc.*, Detroit, Mich., where he will be engaged in electroplating research. Mr. Clark hails from Michigan State College where he acted as assistant to Dr. D. T. Ewing on the American Electroplaters' Society Project #5, The Effects of Metal Impurities on the Physical Properties of Electrodeposited Nickel.

### R. W. Renton and Co. Appointed Rack Coating Applicator

R. W. Renton & Co., with facilities in Cleveland and Indianapolis, has recently completed arrangements with *United Chromium, Inc.* for the application of Unichrome plastisol and air-drying rack coatings. Already well-known in the Ohio and Indiana area, Renton now offers the added service of coating racks with the plastisol Unichrome Coating 218X. With 16,000 square feet of space in their Cleveland plant, the company is equipped to handle large jobs.

### Task Committee on Industrial Wastes Includes Plating Industry

Representatives of 22 of the nation's leading industries concerned with solving difficult industrial waste disposal problems affecting the quality of the country's water resources recently held a two-day conference with the Public Health Service.



# LOWER COST FINISHING

WITH

## Hammond JUNIOR AUTOMATIC

POLISHING AND BUFFING MACHINES

Users of Hammond Junior Automatics report 3 to 7 times faster finishing than hand methods. The Operator merely loads and unloads the machine, result . . . faster, better and more uniform finishing, more pieces per hour with less operator fatigue.

SEND SAMPLES: Send us one finished and several rough samples. You will receive a complete Engineering Report and Production Analysis without obligation.

**Hammond**  
of KALAMAZOO  
Good Machinery Since '82



Model E2PF

**Hammond Machinery Builders INC.**  
1601 DOUGLAS AVENUE ★ KALAMAZOO, MICHIGAN, U. S. A.

The May 9-10 meeting resulted in the establishment of a National Technical Task Committee on Industrial Wastes. The committee then drew up the broad outlines of an Industry-Federal Government approach to the control of water pollution caused by industrial wastes, and set itself three immediate tasks:

1. To assemble a source list of existing processes and practices employed in using, treating and controlling industrial wastes.
2. To assemble a tabulation of research projects concerned with utilization, treatment and disposal of wastes—those underway and those contemplated.
3. To provide a list which will define problems that confront a given

industrial group and for which there is no satisfactory solution, particularly those which are common to more than one industry.

The Committee elected the following officers:

Chairman—*Lyman Cox*, Waste Disposal Consultant, E. I. DuPont de Nemours and Company, Inc., Wilmington, Del.

Vice Chairman—*Dr. Harry Gehm*, Technical Director, National Council on Stream Improvement of the Pulp, Paper and Paperboard Industries, Inc., New York, N. Y.

Secretary—*Louis F. Warrick*, Chief, Technical Services Branch, Division of Water Pollution Control, Public Health Service, Federal Security Agency.

The task committee also established

## In the modern NuTONE plant



### ...6 DIFFERENT INSTALLATIONS By KIRK AND BLUM!

- 2 DUST CONTROL SYSTEMS
- DEGREASING AND ACID ETCHING VENTILATION
- PAINT SPRAY BOOTHS (INSTALLED ONLY)
- PAINT DRYING OVEN AND CONVEYOR
- MAKE-UP AIR SUPPLY SYSTEM

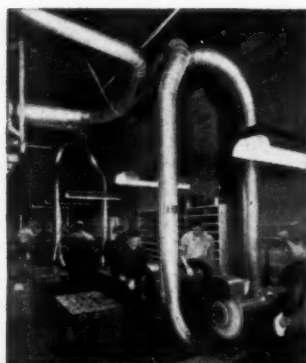
A variety of problems in the Finishing Departments of NuTone Incorporated, were solved by KIRK & BLUM Engineers. Shown here are the various installations which were designed, fabricated and installed by KIRK & BLUM.

Of special importance is the "Make-up" Air Supply System which filters, heats and replaces air exhausted by the other systems, eliminating undesirable winter drafts.

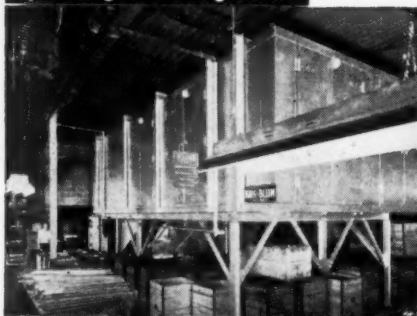
The wide experience of the KIRK & BLUM organization is at your service. "Clean Air . . . the Invisible Tool" can do much to increase the efficiency of your operations. For more details and literature, write The Kirk & Blum Mfg. Co., 2859 Spring Grove Ave., Cincinnati 25, Ohio.

FOR CLEAN AIR . . . THE INVISIBLE TOOL

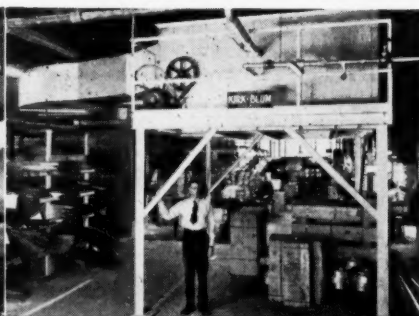
**KIRK AND BLUM**  
DUST AND FUME CONTROL SYSTEMS  
INDUSTRIAL OVENS



Two KIRK & BLUM Dust Control Systems serve the polishing and buffing room.



Overhead conveyorized Paint Drying Oven installed complete by KIRK & BLUM.



"Make-up" air supply system replaces air exhausted from plant.

four major "task groups". These will act as working committees to carry out the functions of the committee at large. They are:

Task Group I—Food Industries, which will consist of sub-committees representing the following industries: Canning, Dairy, Corn, Fermentation, Distillers, Beet Sugar, and Meat.

Task Group II—Mineral Products, consisting of the Iron and Steel, Non-Ferrous Metals, Coal Mining, Other Mining, Petroleum, By-Product Coke, and Gas Industry sub-committees.

Task Group III—Chemical Processing, consisting of Chemical, Textile, Pulp, Paper and Paperboard, Tanning, Rubber, and Electroplating Industry sub-committees.

Task Group IV—General Industries, consisting of the Automotive and Elec-

trical Equipment Manufacturing industries, and the National Association of Manufacturers, sub-committees.

The committee appointed *Earl Devendorf*, Director, Bureau of Environmental Sanitation, New York State Department of Health, to act as its liaison with the various State governments. *Vernon G. MacKenzie*, Officer in Charge of the Public Health Service's Environmental Health Center, Cincinnati, was made the committee's liaison with the Cincinnati laboratory.

The Committee voted to hold its next meeting in Cincinnati, in October, to acquaint itself with the activities of the Environmental Health Center. *Carl E. Schwob*, Chief, Division of Water Pollution Control, Public Health Service, explained that the Cincinnati laboratory will serve as a valuable

source of information and technical assistance to those industries confronted with unfamiliar waste disposal problems.

### Parker Rust Proof's California Plant in Operation

The Pacific Coast plant of *Parker Rust Proof Co.*, manufacturers of *Bonderite*, *Parco Compound*, *Parco Lubrite* and other metal preparation and cleaning products, is now in operation at 3710 Fruitland Avenue, *Maywood, Calif.*

The new plant has been established to bring to Western Industry the advantages and economies of quick supply and on-the-spot manufacture of these widely used products.

At the present time, says *R. W. Englehart*, executive vice president, many of the Parker products are being manufactured at the Maywood plant, and more will be made there in the future. Warehousing of the entire Parker line at the new plant allows prompt service and shipments to the metal working industries up and down the Coast.

Manager of the Maywood plant is *S. N. Headlee*, who has been Parker's Pacific Coast regional manager for the past several years.

### Surface Active Agents Become Surfactants

To put an end to the wide-spread and growing confusion between synthetic detergents and other related "surface-active agents", a new word, *Surfactants*, has been coined by *Intara Products, General Aniline & Film Corp.*, and is presented to the chemical industry to cover all materials that have surface activity, including wetting agents, dispersants, emulsifiers, detergents and foaming agents. This new term (*Surfactant*) is not copyrighted or trade marked. It gives a distinctive name to one of the fastest-growing branches of the chemical industry, with an annual production now of over 800 million pounds.

Surfactants are the unique chemicals which concentrate in liquid surfaces and interfaces. They lower surface tension and tend to increase the surface area. Some act as wetting agents by spreading quickly over solid surfaces and into pores. Others cut into deposits of grease or solid particles and disperse them to facilitate cleaning. Dispersants also keep fine powders suspended in lotions and li-

quids and may make obsolete the old-fashioned label: Shake Well before Using. They are used in insecticides, weed-killers and agricultural sprays.

Other surfactants emulsify oils with water in cosmetics, creams and greases. Still others generate lavish foams and suds in shampoos, while others suppress the suds in washing compounds used in automatic washing machines.

Synthetic detergents may possess many of these properties, but true detergents account for only about 150 of the 750 brand-name surfactants now on the market. For lack of a general name, wetting agents and emulsifiers have been incorrectly called detergents. The new word, surfactants, ends this confusion and gives an apt name to the entire burgeoning industry. The word, detergent, returns to its original and correct meaning, a cleansing agent.

#### Frederic B. Stevens, Inc. Adds to Sales Organization

Frederic B. Stevens, Inc. of Detroit, announce another addition to their sales organization in Mr. George D. Stevenson, of Cleveland, Ohio.

Mr. Stevenson has an unusually diversified business background, having spent some time with Bethlehem Steel Corp., Buffalo Electro-Refractories Corp., the Food Products Div. of Beech-Nut Packing Co. He also spent a brief time with Fisher Body Corp. on methods and time study, and did similar work for the Addressograph-Multigraph Corp.



George D. Stevenson



**SHOW A  
NEAT FIGURE**

**IN SAVINGS ON  
SOLVENT  
CONSUMPTION**

## BLAKESLEE SOLVENT VAPOR DEGREASERS

Blakeslee Solvent Vapor Degreasers are engineered to give 100% oil-free jobs with *lowest solvent consumption*. YES, through patented construction and operational features, they actually **USE LESS SOLVENT**.

They're time-saving too. Metal parts are rendered chemically clean and dry in a few seconds, eliminating tie-ups and rejects in subsequent finishing operations.

Get the benefits of Blakeslee experience and superior performance in the Solvent Vapor Degreaser—engineered for you.

You add less  
solvent daily  
to Blakeslee  
Degreasers

**G. S. BLAKESLEE & CO.**

G. S. BLAKESLEE CO., CHICAGO 50, ILLINOIS  
NEW YORK, N. Y. TORONTO, ONT.

**BLACOSOLV**  
DEGREASERS AND SOLVENT

**NIAGARA**  
METAL PARTS WASHERS

For the past six years he was associated with the Grand Industries, Inc. as industrial engineer.

Mr. Stevenson will cover the Cleveland and adjacent Ohio territory for Stevens.

#### Pennsalt Names Hurley Sales Promotion Manager

The appointment of Paul C. Hurley, Jr., as Manager of Pennsylvania Salt Mfg. Co.'s newly-created Sales Promotion Department has been announced by William P. Drake, vice-president in charge of sales. As head of the new department, Mr. Hurley will be in charge of advertising, promotion research, and the company's salesmen-training program.

Coming to Pennsalt in 1943 as a salesman, Mr. Hurley held the posi-

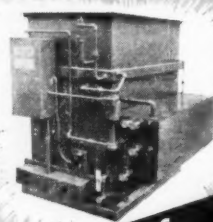
tions of district sales manager and merchandising manager before becoming attached to Mr. Drake's staff about a year ago. During the war he served as a Civilian Instructor for the U. S. Army Air Corps at the Advanced School for Specialized Mechanical Training operated by TWA.

Mr. Drake emphasized that the consolidation of the advertising department, promotion research and salesmen training under one head was primarily for the purpose of assisting the Company's various sales departments to sell a greater volume and minimize sales costs through complete integration of promotion planning.

#### Electric Products Co. Appoints North Central Agents

The Electric Products Co. of Cleve-

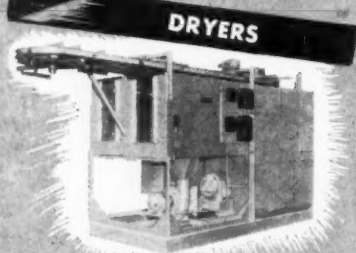
## for METAL PARTS DEGREASING, WASHING, DRYING



DEGREASERS



WASHERS



DRYERS

**OPTIMUS VAPOR DEGREASERS**, all types, vapor, vapor-immersion, vapor-spray, and combinations of these. All sizes from small batch-type degreasers to custom-built monorail or cross-rod conveyor models.

**OPTIMUS METAL PARTS WASHERS**, single or multiple-stage—screw drum or conveyor, mesh belt or monorail types.

**OPTIMUS DRYERS**—embody a specially designed system of adjustable directional jets, temperature, turbulence, and recirculation, to assure adequate drying after washing, before painting, and spotless drying after plating or polishing.

We offer you our experience in planning, designing, engineering and servicing metal cleaning equipment. Contact your local OPTIMUS office for information and advice on cleaning methods, or write us directly.

### "OPTIMUS" TRICHLOROETHYLENE

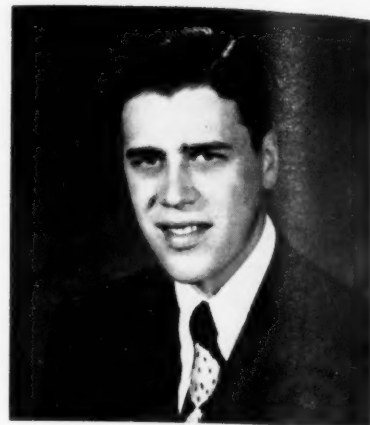
**"OPTIMUS" PERCHLOROETHYLENE**  
The only degreasing solvents for all metals or combination of metals. More stable, both as a liquid and as a vapor, than any other chlorinated solvent. Warehouse stocks in all principal cities and industrial areas.

SEND FOR complete catalog  
and additional information.

**OPTIMUS EQUIPMENT COMPANY**  
11 Water Street      Matawan, N. J.  
Offices in principal cities

# OPTIMUS® EQUIPMENT

FOR CLEANING • RINSING • DEGREASING • PICKLING AND DRYING OF METAL PARTS



J. D. Johnson

founded background of sales and research work, having spent about two years in the latter field with the Research and Development Division of the U. S. Army at the Detroit Arsenal.

With headquarters at the Detroit Office, Mr. Johnson will cover part of the western and northern Michigan territory.

### Acme Opens New Experimental Processing Department

The Acme Mfg. Co., of 1645 Howard Ave., Detroit, Mich. have recently opened an experimental processing department for use in demonstrating their automatic polishing and buffing equipment to prospective users and for determining the best processing methods for sample parts. This new department will be under the charge of Mr. Arthur Losey, Acme Sales Engineer.

This department will be one of the largest and most complete displays of all types of automatic buffing equipment under power. Straight line, rotary semi-automatic and special machines will be set up on the display and demonstration floor. This progressive step by the Acme Mfg. Co., to better serve their customers is in line with their established policy of pioneering, which has brought recognized leadership for nearly half a century.

### Manhattan Rubber Honors 46 More 25-Year Employees

Forty-six employees of Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J., who completed 25 years with the company during the past year were honored recently at the Sixth Annual Dinner of the Manhattan Pioneers. The new members joined a group of more than 600 em-

land, Ohio, have appointed The Klass Company as their representatives in the states of Minnesota, North and South Dakota, and the western counties of Wisconsin.

With offices in Minneapolis, The Klass Co. will handle all the industrial lines of The Electric Products Co.: battery charges; electrolytic motor-generators; general-purpose motor-generators; frequency changers; induction, direct-current and synchronous motors; and direct-current and synchronous generators.

### Heil Equipment Co. Celebrates 20th Anniversary

A recent issue of the Heiline, official house organ of the Heil Process Equipment Co., of Cleveland, Ohio,

tells the story of the firm's first 20 years of operations, and shows the entire administrative staff and pictures of the plant. The firm is a leader in the field of corrosion-resistant equipment for the plating and chemical industries, making pipe, tanks, fittings, heating units, and other equipment in a wide variety of corrosion resistant materials.

### Johnson Joins F. B. Stevens, Inc. Organization

Frederic B. Stevens, Inc., announce the appointment of J. D. "Don" Johnson, of Detroit, to their Sales Organization.

Mr. Johnson is a graduate of the University of Detroit, where he received the Degree of Bachelor of Mechanical Engineering. He has a well-

ployees with services running from 25 to 57 years, believed to be a record in the North Jersey industrial area where Manhattan was one of the first companies to introduce the service emblem plan.

The 46 new Pioneers received gold lapel buttons, while members entering new five-year groups were presented with additional diamond studs. *F. L. Curtis*, vice-president, with 57 years of service, and *Charles Kuhn*, a salesman in the company's New York Office, with 56 years, are Manhattan's oldest Pioneers. There are also five retired Pioneers with 50 or more years of service.

#### McGean Chemical Co. Moves Offices

The McGean Chemical Co., manufacturers of nickel salts and anodes for the plating industry have recently moved their offices from 25 Prospect Ave. to 101 Prospect Ave., Cleveland 15, Ohio. The new offices are in the Midland Bldg.

#### Sendzimir Receives Galvanizers Committee's First Annual Award

*Tadeusz Sendzimir*, vice president of *Armzen Co.*, and the inventor of the Sendzimir process of continuous galvanizing, was the recipient of the first annual award of The Galvanizers Committee, which is sponsored by the American Zinc Institute. The presentation of a bronze plaque, suitably inscribed, marked the award to Mr. Sendzimir for fundamental achievements in the art of galvanizing sheets.

Mr. Sendzimir, who was born and educated in Poland, moved to Shanghai, China in 1918 where he developed his basic idea of continuous galvanizing without pickling or fluxing, his first experiments being carried out on wire. In 1929 Mr. Sendzimir came to the United States and



Tadeusz Sendzimir, right, receives the first annual award of the Galvanizers' Committee from J. L. Schueler, Chairman of the annual award committee.



Du-Lite is the "tried and true" method for black oxidizing all parts of steel except stainless. Du-Lite is used for its attractive, rust-resistant finish on many parts for typewriters, business machines, fire arms, cameras, binoculars, razor blade holders, filters, aircraft engines, spark plugs, and many others. If this listing suggests that Du-Lite could advantageously be used on your product, do not hesitate to call for one of our qualified, technical field men. They are located within easy distance of all industrial centers.

## THE DU-LITE CHEMICAL CORPORATION

110 RIVER ROAD — MIDDLETOWN, CONNECTICUT

DO IT RIGHT WITH DU-LITE

then returned to Europe where his work was extended to strip coatings. In 1935, in conjunction with the *Armco Steel Corp.*, the Armzen Company was formed for the purpose of furthering the inventions of Mr. Sendzimir.

It is the purpose of The Galvanizers Committee to present a similar award each year in recognition of distinguished service and valuable contributions to the galvanizing industry or related field, the recipient to be selected by the Council of The Galvanizers Committee which represents the sheet galvanizers in the United States and Canada.

#### New Address for Industrial Chem. & Equip. Co.

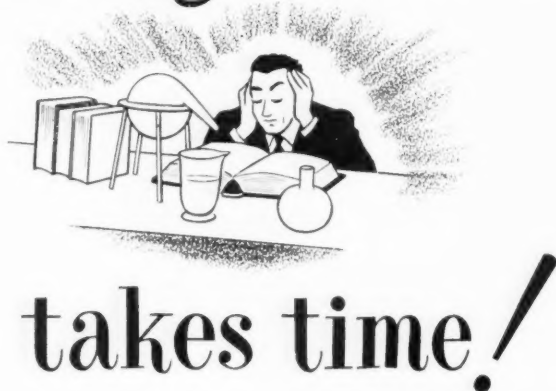
The Industrial Chemical & Equip-

ment Co., formerly of *Builders Exchange, Minneapolis, Minn.*, announces that they are now located in their new offices at 205-11th Avenue South, Minneapolis 15, Minn.

The new location affords considerably larger offices and warehouse space as well as increased space for chemical laboratory expansion.

Industrial Chemical and Equipment Co. specializes in sales and consulting to the metal finishing industry, representing many of the nations leading manufacturers of electroplating, degreasing, and polishing equipment and supplies. In addition to their sales engineering, they maintain a large chemical laboratory where regular plating solution analysis are run for their customers.

# Refining "Know-How"



## takes time!

**O**LD hit-or-miss methods of refining gold, silver and platinum scrap and waste cannot keep pace with modern scientific processes and faster, more accurate equipment.

To do an accurate job today calls for special equipment and processes developed for each type of material. Years of study and experiment are in back of the processes and equipment we now use — and research keeps these methods and facilities up-to-date.

This is the kind of "know how" you should demand if you want the full returns that are rightfully yours. At Handy & Harman you get them. Trained men, long on experience, concentrate on safeguarding the last fraction of value in your shipments.

Send us your next Refining shipment — find out what real "know how" means. You're certain to find it profitable.

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Agents in Principal Cities

### Weaver Opens Plating Supply Firm to Serve Southwestern States

James E. Weaver has started an equipment and supply company to service the Southwest states of Texas, Oklahoma, Arkansas and Louisiana. Mr. Weaver's company will be known as the *Weaver Equipment & Supply Co.* and will be located at 610 Mayborn Drive, Temple, Texas. He will offer a complete service, including consultation, layout, trouble shooting, analysis, and supplying of equipment, processes and chemicals.

Mr. Weaver's background of over 15 years experience in the plating field includes 5 years in the plating laboratory of *National Cash Register Co.*, Dayton, and 4 years as General

Foreman and Process Engineer with *Hickok Mfg. Co.*, Rochester, New York. In Rochester he helped inaugurate metal finishing training at Rochester Institute of Technology, and taught Electroplating at that Institute for the night school.

Among the companies represented by the Weaver Supply & Equipment Co. are *Enthone, Inc.*, *Roto-Finish*, *Williamsville Buffs*, *Lea*, *Singleton Lucite Products*, and *Belke Manufacturing Co.*

### Losey New Sales Engineer for Acme Mfg. Co.

The *Acme Mfg. Co.*, manufacturers of automatic polishing and buffing machines, 1645 Howard Street, Detroit, Mich., announces the appoint-



Arthur H. Losey

ment of Mr. Arthur H. Losey as Sales Engineer for their entire line.

Mr. Losey will also be in charge of the new processing department which the company has recently installed in their new plant.

Mr. Losey is well-known in the finishing field, having spent 25 years working in the metal finishing industry. Just prior to his association with Acme, he was District Sales Manager in the Cleveland Area for *Frederic B. Stevens, Inc.*

### Electrochemical Industries Moves to New Plant

*Electrochemicals Industries, Inc.*, formerly of Leominster, Mass., have moved to new, modern, and larger quarters at *Jacques St., Worcester, Mass.* where over 12,000 sq. ft. of floor space will be devoted to specialization in the plating and metallizing of plastics and non-conductors, including the application of brilliant coatings by spraying, and the plating of copper, nickel, gold, and silver. Completely modern equipment has been installed, and the operation of the plant will be under the direction of *Dr. Harold Narcus*, nationally-known expert in this field.

### The Electric Products Co. Appoints Washington Agents

The *Electric Products Co.*, of Cleveland, Ohio, have appointed the *Muth-Richards Company* as their representatives in the state of Washington and the panhandle of Idaho.

With offices in Seattle, the *Muth-Richards Co.* will handle all the industrial lines of The *Electric Products Company*.

## Pennsalt Opens New Sales Office in Detroit

The Pennsylvania Salt Mfg. Co., today announced the opening of a new District Sales Office to serve industrial customers of Detroit and southern Michigan.

Harry C. Potts, District Sales Manager of Pennsalt's Heavy Chemicals Department, will be in charge. The office is at 1114 Buhl Building, 535 Griswold Street, Detroit. Also making their headquarters there will be W. B. Adam, Heavy Chemicals sales representative, and Willis J. Stoddard of the Special Chemicals Department.

With the opening of the new Detroit office, Pennsalt is discontinuing its former sales office at its Wyandotte plant. Pennsalt maintains other sales offices in Philadelphia and Pittsburgh, Pa.; Paterson, N. J.; Cincinnati, Ohio; Chicago, Ill.; Appleton, Wis.; Bryan, Texas; Los Angeles, Calif.; Portland, Ore., and Tacoma, Wash.

## Don Mason New Sales Manager for Colonial Rubber

The appointment of Donald E. Mason as General Sales Manager of Colonial Rubber Co., Ravenna, Ohio, has just been announced by Howard Farhas, executive vice-president of The U. S. Stoneware Co. and its affiliated companies.

Mr. Mason was associated with The B. F. Goodrich Co. for over 8 years gaining wide experience in the rubber industry, especially in solving special or custom molding problems.

Mr. Mason joined the B. F. Good-



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Possible cost savings in chromic acid anodizing, as well as in other metal treatments such as copper stripping, brass pickling, magnesium dips and chromium plating, are indicated through the use of oxidation-resistant cationic exchange resins. In a preliminary investigation by Mutual Chemical Company of America, certain commercial resins have been found to be stable in the presence of chromic acid. As a result, these resins may be used for removing dissolved metals from chromic acid solutions with the recovered chromic acid made available for re-use. An added advantage is in minimizing the problem of waste disposal.

Write today for a copy of "Regeneration of Chromic Acid Solutions by Cation Exchange" Mutual's Serial No. 65.



**MUTUAL CHEMICAL CO. OF AMERICA**  
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rich Co. upon receiving his B.S. degree in marketing from Ohio State University in 1938. During the war he was associated with the Atlas Powder Co., rejoining Goodrich at the end of the war in the Sundries Sales Division of the Industrial Products Department.

## Raybestos-Manhattan, Inc. Announces New Officers, Director

George R. Weber was elected Treasurer of Raybestos-Manhattan, Inc., at the annual meeting of the Board of Directors recently, succeeding W. H. Dunn, who has retired. W. S. Simpson was elected as Secretary, and W. Ward Kievit a Director of the corporation.

In addition to his new responsibility

Mr. Weber has been a Director and Vice President of Raybestos-Manhattan, Inc., since the formation of the Corporation in 1929 and is also General Manager of the United States Asbestos Division, Manheim, Pennsylvania.

Mr. Simpson, recently appointed Assistant General Manager of the Raybestos Division, Bridgeport, Conn., has been a Director of the corporation for two years.

Mr. Kievit, who makes his headquarters at the Corporation's main office in Passaic, New Jersey, has been Secretary since 1946 and Comptroller since 1948. With his added duties as a Director he has relinquished his duties as Secretary.



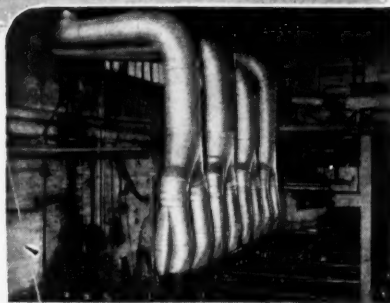
Donald E. Mason

# Ohio FUME AND DUST REMOVAL SYSTEMS TANGIBLE DOLLAR SAVERS

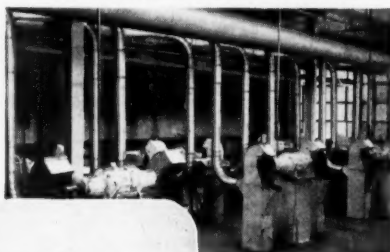
● Records on hundreds of Ohio Blow Pipe jobs prove without question that production output materially increased and employee absence and complaints radically decreased after the installation of an Ohio System for ventilation of fumes from plating and rinse tanks and dust collection from grinding, polishing and buffing.

Ohio Systems are not standard fit-all systems. They are designed and engineered to meet your individual requirements. Ohio engineers, thoroughly experienced in their field, make a careful, exacting survey of your plant and an analysis of conditions and then plan the system that will meet most efficiently your special needs and conditions.

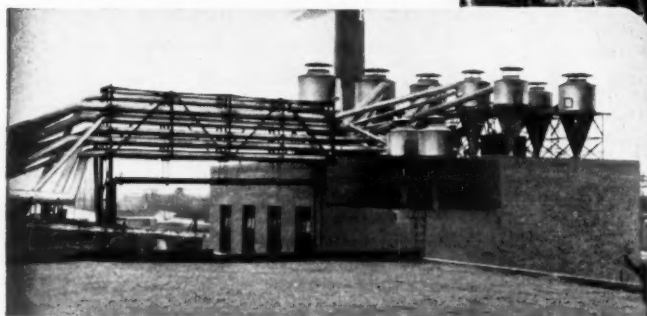
Call, write or phone today and let Ohio engineers make a survey and give you, without obligation, an estimate.



Fumes Removal Installation in Plating Room



Dust Collecting System for Buffing Machines



Cyclone Type Dust Collectors

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## Kraft Chemical Represents Better Finishes & Coatings in Mid-West

Gerald Kraft, sales manager of Kraft Chemical Company, 917 W. 18th St., Chicago 8, Ill., has announced that the company has been appointed Mid-West sales representatives for Better Finishes & Coatings, Inc., Newark, N. J., manufacturers of paint, plastic and chemical products.

Kraft, large distributors of industrial chemicals of all types throughout the Mid-West, will carry substantial warehouse stocks of the Better Finishes line in Chicago, Detroit and at other key points. Featured among BFC products is the high quality technical grade Chromic Acid Flake, of which the Newark firm has recently

announced commercial production.

## Apex Chemical New Distributors for Optimus

Mr. Laurence S. Watson, President of Apex Chemical Mfg. Corp., manufacturers of alkali and emulsion cleaners, is pleased to announce that Optimus Equipment Co. has appointed Apex Chemical Mfg. Corp., 1745 W. Grand Blvd., Detroit 8, Mich., as Exclusive distributors of Optimus Vapor Degreasers, Metal Parts Washers, Dryers, Optimus Trichlorethylene and Optimus Perchloroethylene.

In conjunction with the appointment of Apex Chemical Mfg. Corp. as distributors, Mr. Watson also announces the appointment of Mr. Joel N. Cooper, as Sales Manager of the Industrial

Cleaning and Chemical Sales, Mr. Cooper, formerly with Detrex Corp. for over nine years, has had wide experience in various sales and service of the company's business. He is well known for his contributions in alkali and emulsion as well as solvent-vapor degreasing.

## Klem Chemicals Adds Two Service Engineers

Klem Chemicals, Inc., takes pleasure in announcing the addition of two field service engineers to their staff.

Mr. Richard Collins will work out of the main office of Klem Chemicals, 14401 Lanson, Dearborn, Michigan, and will service accounts in Detroit and the Flint and Saginaw section. Mr. Collins is a graduate of the University of Detroit in Chemical Engineering, and has had two years experience with the Harshaw Chemical Company.

Mr. Robert Furrow will be Klem's Grand Rapids representative, and will service accounts in western Michigan. Mr. Furrow was formerly associated with the Detroit Ordnance District and the King Seeley Corp.

## Manufacturers' Literature

### Vapor Degreasing Manual

Optimus Equipment Co., Dept. MF, Matawan, N. J.

This firm has published a new booklet on vapor degreasing which gives detailed engineering information on the process and the equipment used, together with information on maintenance, installation, operating instructions, solvent recovery, and many other points of importance to the successful operation of this versatile cleaning method. A description of the various types of degreasing equipment manufactured by the firm is also included. Copies may be obtained by writing to the above address.

### Steam Cleaner Operation and Maintenance

The DuBois Company, Dept. MF, Cincinnati 3, Ohio.

This firm has just published a nine page booklet on the operation and maintenance of steam cleaners.

The booklet contains general information on the steam cleaner and a

simple schematic diagram to illustrate its operating principles. One of its principal features is a list of possible sources of coil scale build-up which enables steam cleaner users to circumvent these troubles.

Other useful features are general information on the use of steam cleaners for most efficient operation and a list of Do's and Don't's to obtain greatest efficiency and economy and to maintain equipment in top operating condition. Finally, compound recommendations for various types of cleaning jobs are given.

#### Heavy-Duty Cleaning Compound

*Detrex Corporation, Dept. MF, Box 501, Detroit 32, Michigan.*

A heavy-duty, alkaline cleaning compound that has been developed for the cleaning of steel prior to vitreous enameling, is described in a folder that has just been released by this firm.

#### Telling the Age of a U. S. Patent

*Invention, Inc., Patent Reporting Div., Munsey Bldg., Washington, D. C.*

This firm has just published a folder entitled "Telling the Age of a United States Patent." This folder lists the number of each Patent, Reissue, Design, and Trade Mark granted at the beginning of each calendar year from 1836 to date. Anyone wanting a free copy of this useful and interesting folder may have one without obligation by writing on business letterhead to the above address.

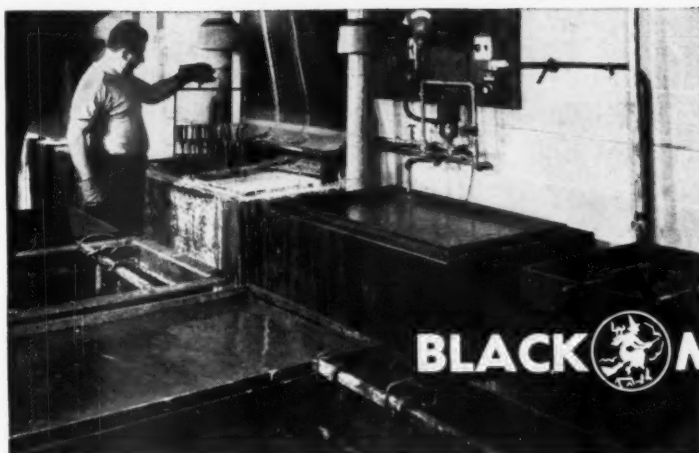
#### Surface-Active Agents for Metal Cleaning

*Monsanto Chemical Co., Dept. MF, St. Louis 4, Mo.*

Two non-ionic type surface active agents designed principally for industrial use are described in detail in a new bulletin available from this firm.

They are Sterox No. 5 and Sterox No. 6, both polyoxyethylene thioethers. Both are compatible with anionic and cationic type detergents and effective in hard water or in the presence of metallic salts, it is claimed.

The five-page bulletin includes data on chemical and physical properties, solubility and surface tension. Suggested applications in textile and metal cleaning operations are given.



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#### BLACK-MAGIC ONE BATH PROCESSES

**FASTER PENETRATION** due to higher oxidation potential and catalysis gives a fine, oxide black that will not rub off.

**QUALITY . . .** Laboratory control and highest quality chemical components insure uniformity.

**TROUBLE FREE . . .** Each installation engineered to needs of specific requirements and periodically supervised by competent chemical engineers.

**Cut time and costs by consulting us at once!**



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#### MITCHELL-BRADFORD CHEMICAL COMPANY MODERN METAL FINISHES

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BLACK-MAGIC OXIDE BLACKING SALTS  
WITCH-DIP & WITCH-OIL FINAL FINISHES



SILCO Glass-Base PROTECTIVE COATING  
HEAT TREATING SALTS, CLEANERS, ETC.

#### Steam Hook-Ups

*Sarco Co., Dept. MF, Empire State Bldg., N. Y. 1, N. Y.*

This firm has just published the sixth enlarged edition, 64 pages, on *Steam Hook-Ups* for steam traps, air vents, and industrial temperature controls, with additional valuable technical information. Copies are offered free to maintenance engineers who write on their firm's letterhead.

#### Flexible Vacuum Hose for Dust and Abrasives

*B. F. Goodrich Co., Dept. MF, Akron, Ohio.*

Industrial vacuum hose, which handles dust, abrasive scrap and toxic

fumes in many industries, is pictured and described in the latest catalog section on the subject issued by the above firm. Copies may be obtained by writing the company at its Akron, Ohio, headquarters. The publication pictures and describes the construction of the various lines and types of hose, lists recommended uses and gives specifications.

#### Surface Active Agents

*Carbide and Carbon Chemicals Div., Dept. MF, Union Carbide and Carbon Corp., 30 East 42nd St., New York 17, N. Y.*

A new 8-page folder entitled "Tergitol Surface-Active Agents" is now available from this firm. Properties.

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FOR TROUBLE-FREE  
SILVER PLATING



**"AA"**  
**silver**  
**anodes**

**silver**  
**cyanide**

APW "AA" Anodes insure better production, because of:

The large reduction in the amount of rejects of finished goods. Less stripping.

Full use of anode (no lace or herring bone formation). Less scrap.

Uniform dissolution of the anode, thereby maintaining a nearly constant anode area, facilitating computation of effective surface (of particular interest to larger plants).

Cleaner, brighter finished work . . . always.

Every anode lot is laboratory tested and guaranteed to give complete satisfaction under normal conditions.

APW Silver Cyanide meets all silver plating requirements. Its quality is consistently highly uniform and **FREE FROM IMPURITIES**. Due to its uniform particle size, APW Silver Cyanide dissolves faster.

Furnished in 100 or 1,000 ounce drums. We can ship any quantity promptly from stock.

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uses, and specifications of "Tergitol" wetting agents 7 and P-28 and of Tergitol penetrants 4, 08, and EH are given. Data on average wetting times for the different products in various acid, base, and salt solutions are presented, along with information on the effects of organic solvents on wetting time. A useful table for the selection of the most efficient Tergitol surface-active agent for any given application is featured.

A technical data sheet on the new Tergitol dispersant TMN-650 is also offered. A surface-active agent of the non-ionic type, TMN-650 is a 100 per cent active product claimed to be compatible with anionic, cationic, and non-ionic surface-active agents. It is use-

ful as a wetting agent, emulsifier, and lime-soap dispersing agent, especially for any operation in which the problem of insoluble metal-soap formation exists.

Copies may be obtained by writing.

## New Bulletin Features Protection for Shot, Sand Blasters

*Mine Safety Appliances Co., Dept. MF, Braddock, Thomas & Meade Sts., Pittsburgh 8, Pa.*

A new 4-page bulletin describing personal protection equipment for shot and sand blasters has been prepared by *Mine Safety Appliances Co.*

Featured in the bulletin are the M.S.A. Abrasive Mask and M.S.A. Blastfoe Abrasive Helmet—two air-

line-type respirators with protective hoods for protection against the harmful dusts and high velocity abrasives found in shot and sand blasting rooms. Approved by the U. S. Bureau of Mines, both units employ compressed air under precise control to provide breathing safety for the wearer.

Also included in the bulletin are photographs and detailed information on M.S.A. Air Supply Accessories, including a diaphragm-type air compressor, the M.S.A. Clean Air Blower, valves, filters and pressure regulators.

Write for Bulletin No. CS-26.

## Chlorine Treatment of Water

*Fischer & Porter Co., Dept. MF, Hatboro, Pa.*

A bulletin entitled "Chlorine Treatment of Municipal Water," has just been released by this firm. It summarizes present-day processes and equipment, providing a yardstick for checking either present facilities or possible future requirements.

Flow diagrams and illustrations contained in this bulletin describe the use and advantages of process instrumentation in municipal water treatment.

## Tumb-L-Matic Process

*Lupomatic Industries, Inc., Dept. MF, 4510 Bullard Ave., N. Y. 66, N. Y.*

This firm, manufacturers of the Tumb-L-Matic line of equipment, compounds and supplies, has just issued two new illustrated bulletins that give complete specifications on two types of tumbling barrels.

Bulletin No. XL-50 describes type XL wet-process tumbling barrel, which can be used for deburring and cutting down forgings, stampings, castings, and for wet ashing of plastics. The "XL" features heavy self-aligning bearings, sturdy framework, and a dependable chain drive from a heavy-duty motor. It is made in six standard sizes with single tumblers, or in multiple units containing up to as many as six tumblers, either entirely enclosed or with open frame. Tumb-L-Matic XL can also be adapted for wet ball burnishing operations.

Bulletin No. MU-50 covers Tumb-L-Matic's F and S multiple unit tumbling barrels for either wet or dry process. Both types of multiple unit barrels are used for heavy production deburring and for cutting down and finishing wood, plastic and metal parts. Model "F" is a horizontal multiple unit.

available with open or fully enclosed frame. Model "S" is a vertical multiple unit with open frame construction.

These units are independent and can be arranged in any multiple form to suit the requirements of floor space and headroom. They are available entirely enclosed or with open frame construction; with tumblers arranged vertically or horizontally. Different types of products and operations can be scheduled simultaneously, making available large volume capacity. This flexibility is possible because each tumbler in a multiple unit is adjusted to the speed required for its particular process and work, and each is started and stopped by an individual clutch.

General recommendations of the Tumb-L-Matic compounds that will give best results for each type of barrel are offered in each bulletin. For free copies write directly to the above address.

#### New Booklet on the Wheelabrator

American Wheelabrator and Equipment Corp., Dept. MF, 19 South Byrkit St., Mishawaka, Ind.

"The Airless Wheelabrator . . . What It Is . . . and What It Will Do" is the title of a revised booklet just published by this firm.

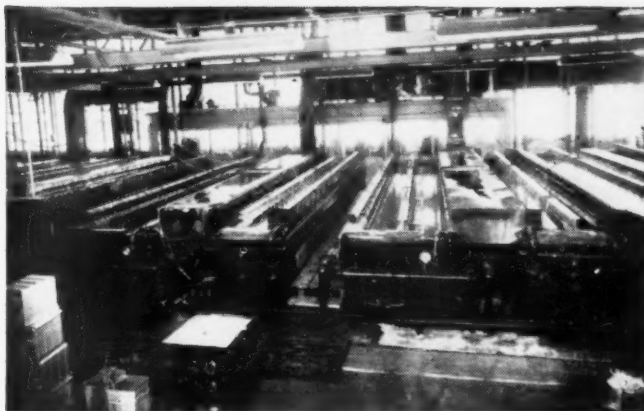
This new 24-page booklet, as the title implies, explains the Wheelabrator method of airless blasting, describes the various types of machines available, and discusses the application of this process to various metal cleaning, finishing, and shot peening problems. Typical parts cleaned in the machine are pictured along with actual installations of the various types of equipment. The text is amplified by photographs, line drawings, and diagrams.

Anyone interested in knowing about this airless abrasive blast cleaning method will find the answers to many of their questions in this new catalog. A copy may be obtained free by writing.

#### News from California

The California Department of Industrial Safety is making available in printed form to members of the plating industry copies of the new California general industry safety orders which became effective early this year. The new orders, promulgated after

### This Program Gives You PERMANENT PROTECTION *Against Corrosion* During METAL FINISHING!



To help you *permanently* control corrosion of equipment used for metal finishing, Haveg Corporation offers you this 2-point program:

1. Personal cooperation in the engineering and installation of Haveg tanks and other equipment
2. Complete manufacturing facilities to mold Haveg equipment to fit your individual needs

This means a *permanent* solution to your corrosion problems during metal finishing. That's because molded plastic Haveg is resistant throughout its entire mass to practically all solutions used for finishing metals. Moreover, you have equipment virtually tailor-made for longer service life, improved production. Many standard shapes available—including tanks, piping, fittings, valves, etc. Write for new Haveg Engineering Bulletin F-6.



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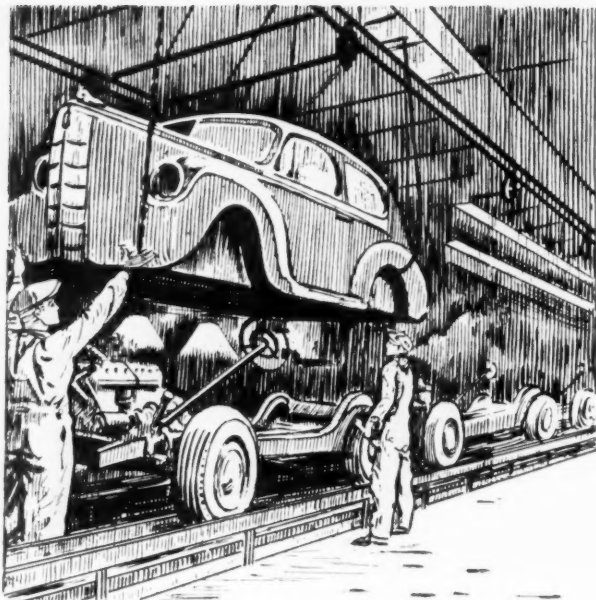

five years of work, modernize safety rules in line with the requirements of new methods and processes, new types of machinery and new industries.

Allied Metal Treating Co. has opened a new plant at 359 West Del Monte Street, Pasadena, Calif., with Russell Lowrey, well known metallurgist, as supervisor.

Jack F. Brossart, Pacific Coast manager for the Industrial Filter & Pump Manufacturing Co., Chicago, left Los Angeles on May 15 for several weeks of main-office contacts in Chicago and the adjacent area.

Fred Littlejohn, 2326 East 38th Street, Los Angeles, has been named factory representative for Poly Products, Pasadena, Calif., manufacturers of grinding and polishing equipment.

Gerald L. Shirley, of Spokane, Wash., has purchased the Northwest Plating Co., Spokane, from John Matthews, Jr. Mr. Shirley formerly was associated in various metal finishing capacities with such firms as Cascade Fixture Co., Seattle, and Spokane Stove Co. and Brown-Johnson Electric Co., of Spokane.



# MOTOR CITY PLATING NEWS



by  
*Edward Fiume*

*DeLuxe Hard Chrome Service*, 1559 E. Woodbridge, Detroit recently appointed *Buck M. Rogers* as General Sales Promotion Manager. The announcement was made by R. A. Stulz, president. The company is engaged in hard chrome plating of tools, dies and gauges.

Like many other platers, you may have a pet plating idea or gadget or mechanism that you feel could make you a lot of money—if you could only afford to get it on the market.

*Joe Wagner*, of *Wagner Bros., Inc.*, 400 Midland, Detroit is interested in those ideas of yours and his company

is willing, if the idea is sound, to fully develop it, manufacture it and distribute it nationally. He recognizes that many good plating items are the result of a practical man's thinking and would be an asset to the trade if marketed. Several of Wagner's newest items are results of this policy.

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Complete Service for Metal Finishing

Products Listed Below Available in New York  
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Take the bugs out of hot weather zinc plating!

*McKeon's*  
**Zinc-Brite**  
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THROWS DOWN HEAVY METAL  
IMPURITIES.

REMOVES EXCESSIVE CARBONATES

Effectively cleanses your zinc solution of cadmium, copper, lead, tin, mercury, and like contaminations.

Prevents harmful accumulation of carbonates.

No filtering required. No waiting period. Economical.

WRITE FOR A FREE SAMPLE  
(Enough to treat 240 gal. of zinc solution)

*Sulphur Products Co. Inc.*  
Greensburg 7, Pa.

Chester Borlet, formerly of the Detroit office of the Harshaw Chemical Co., has joined the *Glenvale Products Corp.*, 1165 Beaufait, Detroit as plating superintendent. Chet leaves Harshaw after 15 years of sales and serving their products and takes with him a wealth of plating know-how. Glenvale Products are manufacturer and platers of automotive and refrigerator die castings.

\*\*\*\*\*

John McCullough died in Detroit the latter part of March. He had been associated with the plating industry for some 25 years as chemist with General Motors Ternstedt Division, United Platers, Inc., Grand River Plating Co., all of Detroit, and with Eaton Mfg. in Cleveland and the Trilex Corp. in Wayne, Mich.

\*\*\*\*\*

Gene Lyons, of Harding Mfg. Co., Detroit died on April 30, 1950. He was employed as plating foreman by Harding. Previously, he had spent several years in the same capacity at Metal Process Corp.

\*\*\*\*\*

Charles H. Aukerman, chairman of the board of the *Udylite Corp.* died May 6th in a LaJunta, Colorado hospital.

He came to Detroit in 1917 with the *Parker Rust Proof Co.* and became president when the Parker Co. organized the Parker-Wolverine Co. When that firm was taken over by Udylite, Mr. Aukerman became board chairman of Udylite and retained a directorship of Parker Rust Proof Co.

\*\*\*\*\*

The *McGean Chemical Co.*, of Cleveland, announces the opening of a Detroit office to serve the Detroit area.

W. A. Hopkins, district manager, will now operate from Room 1522, Union Guardian Bldg., Congress and Griswold Sts., Detroit. The telephone number is Woodward 1-5260.

\*\*\*\*\*

*McAleer Mfg. Co.*, Rochester, Mich., will now be known as *Higbie Mfg. Co.*


The new name recognizes the close association of Carleton M. Higbie, president, with the company's growth. The company's four divisions will not be affected in any way by the change. Its four divisions will remain as distinct operating entities. They are Avon Tube Division, General Crafts Division, McAleer Mfg. Division (makers of buffing compounds) and the Bronson Reel Co.

# DAVIS-K

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- Brilliant Finish
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- Bottled By Troy Weight
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Stockholders of Udylite Corp., have approved the company's negotiated agreement to acquire *Frederick B. Stevens, Inc.*, manufacturers of foundry supplies, plating equipment and polishing and buffing compounds.

The purchase agreement was reached in January, but consummation was made dependent on approval by stockholders of both concerns. Stevens will now be operated as a wholly-owned subsidiary of Udylite.

To Udylites' five Detroit plants now will be added Stevens' plants in Detroit, Buffalo, New Haven, Windsor and Springfield, O.

\*\*\*\*\*

The Detroit Section of the *Electrochemical Society* was elected to membership in the Engineering Society of Detroit at the March meeting of the Board of Directors. The Detroit Section thus became the 37th Affiliate Society of the ESD, the largest engineering society of its kind in the world.

Officers of the Section are *Chester Borlet*, Chairman and *Margaret Baty*, Secretary. Representatives to the Affiliate Council are *Glenn Coley* and *R. B. Saltonstall*.

The Detroit Section, one of ten local sections of the *Electrochemical Society*, enjoys particular distinction this year in having one of its members elected as national president. He is *Dr. Alfred L. Ferguson*, Professor of Chemistry at the University of Michigan.

\*\*\*\*\*

*H. J. Breithart* is now employed by *Wagner Brothers, Inc.*, 400 E. Midland, Detroit, polishing and plating suppliers, as salesman. He was formerly with *Divine* and *Yerges Buff*.

## Letter to the Editor

### Carbon Disulfide for Silver Brightener

*Walter A. Raymond*, Editor  
*Metal Finishing*  
N. Y. 18, N. Y.

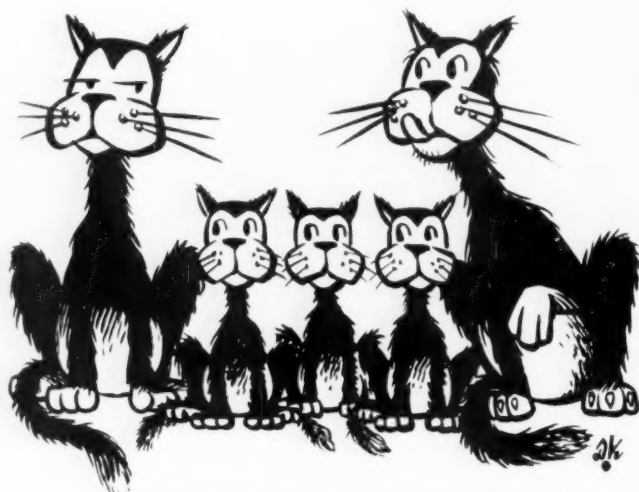
Dear Mr. Raymond:

I read with considerable interest *Marvin Rubenstein's* article on addition compounds in electroplating. I am in full agreement with him on the possible use of sequestrants in the

plating industry. It is practically an untapped field, as far as we are concerned, as pointed out in his paper, and in "Where Do We Go From Here—Part 1", which appeared in the March 1949 issue of *Metal Finishing*.

The purpose of this letter however, is to provide the answer to *Rubenstein's* statement. "The reasons why carbon disulfide was tried by early silver platers . . . will probably never be known," if someone else has not already done so.

The reason is well known and is given by *R. E. Leader* in his definitive "The Early History of Electro-Silver Plating" presented to the British Institute of Metals in 1919. According to *Leader*, "*William Milward*, already mentioned as one of *Elkington's* workmen, noticed that metallic articles in a vat [silver plating], also containing wax molds treated with a solution of phosphorous in bisulphide of carbon, took on a bright appearance. Following this up he convinced himself rightly that to the bisulphide of carbon was attributable this magic touch. *Mr. Elkington* gave him £400 for his secret."



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Leader then goes on to point out that Millward's brothers, Richard and Arthur, as well as *Morris Lyons*, all operators in Elkington's Silver Plating Plant, noted the goings on and promptly sold the "secret" to Elkington's bitterest competitor! The two competitors ultimately joined forces and there resulted among other things, the patent bearing the name of Millward and Lyons . . . And that is why  $CS_2$  was tried by the early silver platers.

The presence of carbon disulfide on the wax molds was due to the fact that a method then in vogue for producing conductive coatings on non-conductors was to dip the object in a solution of phosphorus, the object so treated then being coated with a silver nitrate solution. The phosphorus reduced the silver salt to metallic silver thus producing a conductive coating on the object. Phosphorus is not water soluble but is readily soluble in  $CS_2$ , and for this reason carbon disulfide found its way into the plating tanks.

I hope this clears up the mystery.

Sincerely yours,

JOSEPH B. KUSHNER.

## Associations and Societies

### AMERICAN ELECTROPLATERS' SOCIETY

#### Cincinnati Chapter

The Cincinnati Chapter of the AES had a very interesting meeting in April at the Cincinnati Engineering Society, when thirty members turned out to a very fine dinner to welcome *Dr. E. J. Stareck*, Director of Research, United Chromium, Inc. After dinner, ten additional members appeared on the scene to enjoy two movies on jet aviation and television.

Dr. Stareck then presented a highly educational story on "Electro-color and Patternplate" which was thoroughly enjoyed by all present as was attested by the lively question period which followed.

Members of the Cincinnati Chapter were sorry to learn that their immediate past President, *Fred Brune*, was transferring from the Cincinnati Chapter, due to the fact that he has been appointed to a new position in Marion, Ohio.

#### May Meeting

Twenty-seven members of the Cincinnati Chapter were present for dinner for the final formal meeting of the year to welcome *Dr. F. A. Lowenheim*, Metal & Thermit Corp., Woodbridge, N. J. Ten additional members appeared after dinner to witness two movies on television and atomic energy.

President *Ezra A. Blount* called the meeting to order, announcing that this was Past President's night with three former Presidents present. The Secretary read a Resolution honoring *Fred G. Brune's* services as immediate Past President. This Resolution was unanimously adopted with an ovation which unfortunately Brune was not able to witness since he has moved to Marion, Ohio.

It was announced that *Chas. T. Nuzum*, *R. D. Miller* and *Ezra A. Blount* would serve as Delegates to the Convention in Boston, while *Fred L. Hintze* would be an Alternate.

The President then asked for a discussion on the Proposed By-Laws for The Cincinnati Chapter which had been sent to each member. The By-



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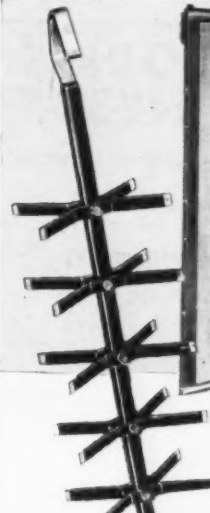


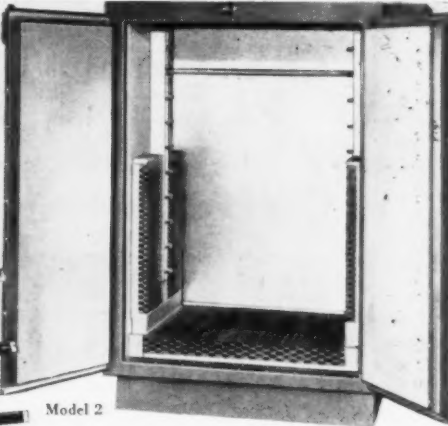
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Laws were approved as drawn up, and forwarded to the A.E.S. Law Committee for their review.

Carl Claybaugh presented a report on the Annual Stag Picnic which will be held on July 7 in Mt. Airy Forest with members of the Dayton Chapter as our guests. A baseball game between the two Chapters will be a highlight of the festivities.

The meeting was then turned over to Dr. Lowenheim who talked on the Electroplating of Tin, discussing both its present uses as well as its potential uses. He pointed out the properties of tin-zinc, and its advantages in being economical to use. The speaker suggested that tin was very easy to plate, and then gave a history of tin with the evolution of plating on tin.

His talk was profusely illustrated with slides which showed the advantages and disadvantages of both acid and alkaline baths as well as the pounds of metal plated and the time to deposit same. Dr. Lowenheim spent considerable time discussing his development of potassium stannate solution demonstrating its advantages over Sodium Stannate Baths. He concluded his talk in stressing the importance of

anode reaction on stannate solutions with emphasis on anode behavior.

A short question and answer period followed after which the members enjoyed a bull session as the guests of Chipman Supply Co.

#### Southeastern Branch

The Southeastern Branch of the A.E.S. held its regular monthly meeting on May 12th at the Robert Fulton Hotel.

Due to the amount of business to be taken care of, and this being election night for the Branch, the meeting was called to order at 6 P.M. The following officers were installed for the coming year.

E. J. Slemmons, President, of Spartanburg, S. C.; D. J. Griffin, 1st. Vice-President, of Birmingham, Ala.; Geo. W. Taylor, 2nd Vice-President, of Jacksonville, Fla.; Wm. T. Weymouth, Sec'y. & Treas., Atlanta, Ga.; Dr. Fred W. Cox, Librarian, Georgia Tech., Atlanta, Ga.

Board of Managers—R. E. Norman, Birmingham, Ala.; H. R. Stogner, Atlanta; C. H. Hohner, Atlanta.

It being customary for the Branch to send one delegate to the Convention with an expense allowance, our good

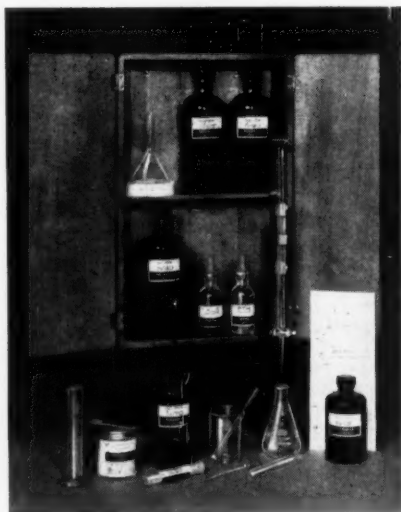
friend Dr. Fred W. Cox was elected as our choice. The following members were appointed by our president to serve with him at the Convention. Delegates, Dudley Smith, Spartanburg, S. C.; Carl Cartledge, Atlanta. Alternates, E. J. Slemmons, Spartanburg; H. R. Stogner, Atlanta; and Geo. W. Taylor, Jacksonville, Fla.

It was moved and seconded that the June meeting would be held on June 30.

At this time after some discussion a motion was made and seconded that a copy of our minutes be sent to *Metal Finishing* each month for publication, also that our President appoint a publicity chairman for the purpose of obtaining some much-needed publicity from our local newspapers. The appointment to be made at our next meeting.

Our business attended to, we were then served a very good steak dinner; 24 members and guest were present. Our guest speaker of the evening Dr. R. V. Vanden Berg, of the Aluminum Company of America was then introduced by Dr. Fred W. Cox. Dr. Vanden Berg presented a very interesting and illustrative program on the plat-

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ing of aluminum alloys. The audience attention was complete throughout the program, and considerable discussion followed.

### Los Angeles Branch

The control and analysis of plating solutions was the subject of a talk presented at the educational session of Los Angeles Branch, American Electroplaters' Society, on May 10 by George Kent, a member of the Southern California plating supply firm of Shepard & Kent.

He emphasized that while it is not necessary to make a professional chemist out of each plater, a knowledge of the fundamentals of solution analysis and possession of basic laboratory test equipment are practically "musts" in the modern plating shop.

The chief object of his talk was to explain how the average plating shop operator could acquire the necessary knowledge to solve routine solution problems or, at least, to put him in position to know what to do until the "doctor" comes—the doctor, in this case being a professional chemist or solution expert.

He referred the members of the

branch to the annual *Guidebook-Directory* published by *Finishing Publications, Inc.*, as a source of practically all the information a plater might need in order to establish a solution control laboratory in his shop and how to operate it profitably and effectively.

The business session was directed by President Richard Wooley, of United Chromium, Inc. The branch's new procedure for expediting meetings was employed. Under the new plan, all business matters are first thrashed out by an executive committee which meets prior to the general meeting. The committee's recommendations are usually accepted and acted upon by the membership. The system cut a full hour from the usual time devoted to the business sessions.

The executive committee recommended that the June meeting of the branch be moved forward to June 7 in order not to conflict with the Boston convention. The recommendation for amounts of travel expenses to be allowed the delegates to the national convention also were approved.

John F. Beall reported on the status of the sustaining membership commit-

tee, and suggested that eastern and mid-western firms which have branches in California might be persuaded to assign one of their various sustaining memberships to the West Coast in order to bolster this section's claims for a research project. The consensus of opinions was that it was very probable that some firms which support three or four research project memberships, might be persuaded to enter one in the name of the Pacific Coast division.

Guests introduced included Arthur Heath, of L. H. Butcher Co.; Keith Holzclaw, of Industrial Electronics & Transformer Co.; Bert Neal and Carl Forsberg, of the George E. Nichols Co.; Frank O'Dell's application for membership was approved.

### Detroit Branch

The April meeting of the Detroit branch of the AES was held Friday, the 14th, at the Statler Hotel. The new officers elected by the branch members were:

E. A. Hahn, President; F. L. Clifton, 1st Vice-President; H. E. Head, 2nd Vice-President; J. Gurski, Sec'y-Treasurer; C. Eorlet, Board of Managers;

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New 1950-51 officers of the Detroit Branch: (Left to Right) Ed. Hahn, Pres.; Frank Clifton, 1st V.P.; Herb Head, 2nd V.P.; John Gurski, Sec'y-Treas.; Walt Pinner, Alternate; Lee Morse, Delegate; L. C. Borchert, Educ. Chairman; Bob Redmond, Delegate; Dick Saltonstall, Alternate; Chester Borlet, Board of Managers; Cleve. Nixon, retiring President.

L. C. Borchert, Educational Chairman; R. L. Redmond, Delegate; L. M. Morse, Delegate; F. L. Clifton, Alternate; W. L. Pinner, Alternate; and R. B. Saltonstall, Alternate. Sixteen new members were also elected to membership.

The speakers of the evening were J. Homer Winkler, Technical Advisor at Battelle Memorial Institute, and

Harold W. Faint, of Industrial Filter and Pump Co.

Mr. Winkler talked on "Electrodeposition in the Printing Industry." His talk covered electroforming, electrotyping and chromium plating of printing surfaces.


Mr. Faint's talk, "Recent Filtering Developments," described some of the newer filtration advances.

The Detroit Branch has acquired a new official photographer — Hank Tiedeman, of Wagner Bros., Inc.

### Eleventh Annual New England Regional Meeting

There must have been a weather man on the committee in charge of picking the date for this year's New England Regional Meeting, for the day chosen turned out to be the first warm and pleasant day of Spring, as befits the eleventh annual holding of this affair. The meeting was held at the Hartford Club, in Hartford, Conn., and was very well attended. Two hundred men and one woman were on hand for the technical sessions. (Platers in New England should take a lesson from genial "Cy" Simons, who seems to be the only one possessing enough charm as to have a lady sit contentedly beside him throughout the 5-hour technical session).

The meeting was notable for the number of Past Presidents of the Society who were present; Ken Huston, Ellsworth Candee and George Hogaboom. In addition, there were Art Logozzo, present National President



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who acted as Technical Chairman, and Cleve Nixon, present 2nd Vice Pres., who delivered a talk.

Howard Boyer, Chief Metallurgist of the American Bosch Corp., spoke on the properties and conditions of the base metals which affect plating. Based on extensive research and fatigue tests on electroplated coatings, he concluded that there must be some alloying between the base metal and the deposit for maximum adhesion. He also proposed that the term "cohesion" would be more appropriate than "adhesion" when speaking of electro-deposits.

Cleve Nixon gave a lengthy talk on the surface finishing of die castings. High spots of his remarks related to buffing speeds for die castings, where he recommended as slow a speed as is practical. He also stated that high quality die castings should only require a parting-line polish before buffing.

Mr. Huston spoke on the finishing of stainless steels, and featured the showing of a large number of treated samples. He also revealed that his firm has developed a molten salt bath

method for gold tinting stainless steel.

Ellsworth Candee spoke briefly on the aims and purposes of the New England Regional meeting. He was the recipient of an Award of Merit Certificate which was voted him at the Milwaukee Convention last year.

Following the technical session a banquet and dancing were enjoyed by over 300 members and guests.

Chairmen for the affair were Mr. F. W. Smith and Mr. A. J. Dankevitch. Miss Julie Majkowski was in charge of the Ladies Program.

### Chicago Branch

At the April meeting 170 members and guests attended the meeting, which had been publicized as a social meeting to which the ladies were invited. The speaker of the evening, Dr. J. H. Monaweck, former Librarian of the Chicago Branch, gave an interesting talk on the many steps involved in the manufacturing and finishing of compacts. These operations include the formation of the alloy, the rolling operation, the three methods of producing the designs on the base metal, and the problems involved in stop-off

lacquers and plating. Those in attendance were amazed at the complexity of the problems of finishing, which at Elgin American is handled on the volume basis. Following Dr. Monaweck's talk there were numerous questions from the floor.

In addition to the speaker of the evening we also presented a sound color movie on "America's First Silver Plate," which covered the activities in electroplating silver flatware since the year 1847. A compact was awarded to the lady present holding the lucky number in the drawing, and a cigarette case was awarded to the gentleman with the winning number. Following the meeting refreshments were served in the dining room.

### ELECTROCHEMICAL SOCIETY



### Faust Elected President of Electrochemical Society

The Electrochemical Society has named two new officers: The new

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President is *Dr. Charles L. Faust*, head of electrochemical engineering research at Battelle Institute, Columbus, O. *R. J. McKay*, chemical engineer for the International Nickel Company, has been elected a vice-president.

Other officers of the Society are vice presidents *Dr. Ralph M. Hunter*,



Dr. Charles L. Faust

manager of Dow Chemical Company's electrochemistry division, and *Dr. J. C. Warner*, president-elect of Carnegie Institute of Technology; secretary, *Dr. Henry B. Linford*, associate professor of chemical engineering at Columbia University; and treasurer, *E. G. Widdell*, R.C.A. Victor Division, Radio Corporation of America. Immediate past president is *A. L. Ferguson*, professor of chemistry at the University of Michigan.

The Society's new president has a long record of scientific service. In addition to other important achievements, Dr. Faust has been a pioneer in the development of electropolishing, a process which eliminates costly time-consuming mechanical polishing methods used on such items as automobile and refrigerator trim. Dr. Faust will also head the Society's board of directors.

The Electrochemical Society, recognized as one of the world's leading scientific societies, is encouraging advancements in many fields of science. According to Dr. Faust, the Society is currently active in the fields of elec-

tronics, luminescence, and the rare metals. The Society is also continuing its long-time interest in research on corrosion, electric insulation, electrothermics, electro-organics, theoretical electrochemistry, industrial electrolytics. It expects increasing applications of electrochemistry in natural sciences such as agriculture and medicine.

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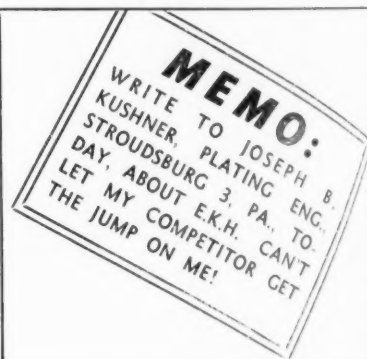
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